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**THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.**

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The Registered Office and Laboratories of the B.C.I.R.A. are at:—
24, ST. PAUL'S SQUARE, BIRMINGHAM.
*Telephone: Central 1895. Telegrams: CIRA.*
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk *(Telephone 332)*

## Forthcoming Events.

MAY 14.
*North-East Coast Exhibition* at Newcastle-on-Tyne.

JUNE 4-7.
*Institution of Gas Engineers*:—Annual general meeting in London.

JUNE 5-15.
*International Foundry Trades Exhibition*, Royal Agricultural Hall, London, N.

JUNE 10-14.
*International Foundry Congress*:—26th Annual Convention of the Institute of British Foundrymen.

## The Balfour Report—IV.

In its last great section the Balfour Report discusses other factors in competitive efficiency. In marketing organisation, it refers to the growth of direct representation as a means adopted by many manufacturers of cultivating export markets, but it is held that the merchant system is likely to hold for many years to come. International exhibitions of the commercial type have not been found profitable by British traders.

The two tendencies in industrial combination are reviewed and the comparative failure of "vertical" combinations is referred to. These are combinations among firms of different types to ensure an unfailing supply of material to the works next in the producing chain. More recently the tendency has been to promote combinations among firms in the same business, either by direct financial amalgamation or by output, selling or price agreements. Public opinion is said to be favourable to the economic advantages of large-scale combinations. The Report urges manufacturers to support their trade associations and even hints at compulsion in this matter.

Standardisation and simplification are next dealt with and, with due regard to certain possible dangers, is urged as very desirable, and a Government grant is urged to the B.E.S.A. to make it less completely dependent on the trades interested.

Education is treated as a factor in competitive efficiency. It is said that industrialists do not desire vocational training, but desire a combined literary and manual training. The Report insists that every industry should make its educational needs the subject of careful inquiry and on co-operation between the industry and educational authorities. Authorities are urged to take steps to ensure that teachers shall become acquainted or keep in touch with the art or craft they teach. Certain other recommendations are made bearing on proposals to extend the school-leaving age.

With regard to research, the Committee finds cause for disquietude in the relations between research associations and industry, on account of the want of response and appreciation on the part of the industries. The "response of the trades to the propagandist efforts of the research associations is frequently most disheartening," and trade associations are urged to take up the matter. The lack of a proper receiving mechanism in the works to make use of research information is held to be one of the difficulties. Nothing less than a revolution in their general outlook on science is stated to be needed. The highly-skilled professional consultant is recommended as useful in certain trades to bring them more up to date. The Committee urges strongly that "there should be no relaxation or curtailment of the efforts of the Department of Scientific and Industrial Research, and no withdrawal of financial support on the part of the Government," and that "the question of State aid for research associations should be determined on a broad and long view of the ultimate national interest, and not merely on results already achieved." The Committee is sympathetic to the idea of a general levy in the industry to provide funds for its research association, fixed by legislation.

Industrial art in relation to design is then treated, and finally the whole question of statistics. A national index of production is needed at regular intervals as well as indices for various trades.

## Metal Mixtures.

The experience recorded recently in our columns by Mr. H. J. Young in his examination of locomotive cylinders is a fitting text for these comments. He states that in the case of these important castings he found no two cylinders alike, in consignments from two experienced locomotive cylinder founders. It is to be presumed, of course, that the basis of the comparison was the chemical composition and the composition of the cylinders, in varying from some predetermined standard, constitutes an example of that lack of strict uniformity and consistency which is desirable, particularly in high-grade castings.

Metal mixtures to-day are calculated from the composition of the materials available. The final desired or specified composition having been decided, this procedure is one with which every modern foundryman is familiar. If this procedure is carried out correctly there still remain two sources of irregularity in the final composition and deviation from the desired result is calculated. Irregularity in the composition of the component materials of the mixture is one of these which is also quite familiar. It is well substantiated that pig-iron, of ordinary foundry qualities, in bulk, may vary considerably from the certified analyses. This is a real difficulty and one that is by no means new, as the early pages of this Journal and the Proceedings of the British Foundrymen's Association testify. Where strict uniformity in final result is required, the chemical analysis of each consignment of pig-iron is hardly sufficient to meet the case. Something more is needed, as the manufacturers of refined pig-iron have found, where the casts of pig-iron are collected and thoroughly mixed in suitable receivers. In the case of scrap, the other component of metal mixtures, the difficulty of obtaining a chemical analysis truly representative of the bulk, in the case of scrap collected from miscellaneous sources, is generally understood. Where returned scrap is used a very satisfactory degree of control over its composition can be exercised, and in such cases it is possible for the scrap to be the most reliable, from the point of view of uniformity, of all the materials charged into the cupola.

XUM

The second cause of irregularity in the final desired composition of the cupola melt is not nearly so generally understood. This arises under conditions where the mixture charged is made up of materials widely different in composition. Under these conditions experience shows that it is possible for considerable variations in the composition to exist in the molten metal tapped out from the cupola. It is appreciated that variations arising out of this cause are less appreciable where the metal is collected in large quantities and a whole charge or several charges gathered together in one receiver.

In these days of high casting-temperatures this, of course, is not always convenient, and where small quantities are drawn at one tap the danger of sizeable variations in composition increases. It must be confessed that irregularity arising in this manner is not easy to demonstrate in a single experiment, and we have to rely for the proof of its existence on the experience with actual castings over a period. Such experience is accumulating and steadily demonstrating the irregularities both in composition and quality which may arise with mixtures made up from components widely dissimilar in composition and character.

There can be no doubt that in the procedure of computing metal mixtures to secure the strictest accuracy in final composition the following additional rules should be added: (a) The pig-iron should be of guaranteed uniformity of composition in itself and (b) the components of the mixture should be as nearly approaching the desired final composition as the limits of melting losses under the particular conditions of melting will allow.

## Correspondence.

*[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]*

### Total Carbon in Cast Iron.

*To the Editor of* The Foundry Trade Journal.

Sir,—Total carbon in this condition has been receiving considerable well-deserved attention in late years. The report on Pinsl's Paper, on p. 327 of your current issue, on the change in total carbon in cupola melting, makes a good companion Paper to that by Norbury before the Iron and Steel Institute meetings in London yesterday. Whilst carbon is picked up in melting in the cupola, it is generally understood that in melting in the crucible it is reduced. Pinsl gives five reasons for the behaviour of T.C. shown by him, but a particular example came under my own notice many years ago in which the total carbon in a casting was 4.50 per cent. when the pig-irons used were T.C. 3.00 per cent. The figure of T.C. 4.50 per cent. was ridiculed, but, as the determination was done by a reputable Scottish consulting chemist and checked by him, there appeared to me to be no reason to doubt the figure, particularly when the conditions of melting were known. The coke was soft and friable; hence it was necessary to use more coke per ton of iron melted, and it was obvious from the appearance of the molten metal in the ladle that a great excess of carbon was present. Hence, whilst Pinsl in his third reason is quite correct, there is the additional reason as to whether carbon is picked up in cupola melting or not in the character of the coke itself. The value of Norbury's Paper in connection with total carbon contents of cast iron, is that he appears to have had a number of samples with carbon above the eutectic line for silicon contents, thus showing that even in crucible-melting carbon is not necessarily lost to any material extent, and the carbon can be present in both cupola and crucible-melted cast iron very much above the eutectic line—hypereutectic. It was quite interesting at the time to have criticism in connection with cooling curves, which suggested the lowering of total carbon by the carbon rising to the surface. Such an imaginary argument was quite good for the discussion to throw doubt upon any result, but there is ample evidence in Norbury's Paper that such arguments were not sound.—Yours, etc.,

E. Adamson.

18, York Street, Sheffield. May 4, 1929.

### Annealing of Cast Iron.

*To the Editor of* The Foundry Trade Journal.

Sir,—On page 229 of the March 28, 1929, issue of The Foundry Trade Journal appears an article, "The Annealing of Cast Iron," by H. H. Beeny, M.Met. On that same page he reproduces a diagram from a Paper by the author, "Properties and Heat Treatment of Cast Iron for Diesel Engines," Transactions of American Society for Steel Treating, September, 1927. This diagram appears on page 460 of the original article, and is referred to on page 461, the statement being made that the diagram was taken from an article by MacPherran and Harper, and appeared originally in "The Foundry" (Cleveland), May, 1923. While most of the data presented in the writer's Paper was original, this particular diagram was quoted, and the writer feels that the full credit for it belongs to Messrs. MacPherran and Harper. For this reason he is calling it to your attention.

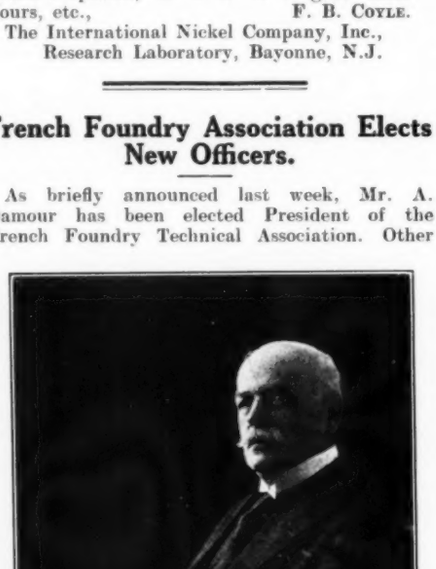
In closing, I might add that I have read the complete article by Mr. Beeny, and consider it a very constructive piece of work, and, in the writer's opinion, he is to be congratulated.—Yours, etc.,

F. B. Coyle.

The International Nickel Company, Inc.,
Research Laboratory, Bayonne, N.J.

## French Foundry Association Elects New Officers.

As briefly announced last week, Mr. A. Damour has been elected President of the French Foundry Technical Association. Other



Mr. A. Damour.

officers elected are:—Senior Vice-President, Mr. E. V. Ronceray (Bonvillain et Ronceray); Vice-Presidents, Messrs. Jules Cury (Deville); Eugene Dady; Jean Derdinger (brassfounder, Paris); Henri Magdelenat (Rosières); Charles Masson (La Mécanique Moderne); Jean Montupet (Montupet & Company, Paris); and Henri Sandre (Périgord); Honorary Secretary, Mr. Charles Koehler (Fonderies de St. Ouen); and Treasurer, Mr. Albert Lardin, of Paris.

## Random Shots.

I have rarely encountered anything more characteristically English than the conferring of a knighthood on Major—now Sir Henry—Segrave, and another on the Manager of the Test Team that has just returned victoriously from Australia. What other country in the world would class sporting achievements of this kind in the same category as public, political and philanthropic services and their like? No doubt in the first instance the sporting gesture is disguised by references to the future of our motor trade, and so on, but that makes no essential difference. In the second connection, however, the occasion seems not merely characteristically English but characteristically twentieth century as well. I suppose we could hardly demand the accolade for the entire team, but, after all, could the Manager have rescued the Ashes unaided? Once upon a time it is even possible that cricket did not require to be managed. . . .

* * *

While we are in this sporting frame of mind, do you remember this little story, that should be especially appropriate just now in view of the nation-wide interest in Derby sweepstakes? A man got into a railway carriage looking extremely miserable, with his overcoat collar tightly buttoned-up. A fellow traveller, seeing his dejected air, ventured to inquire the reason. "Well," said the sad-looking individual, "its like this. I drew a horse in the Calcutta Sweep, and I sold the ticket for fifteen shillings, and now the horse has gone and won!" "Heavens!" cried the other man in horrified amazement, "why, if I'd done a thing like that I'd have cut my throat!" "Well, I have," replied the miserable one, and he unfastened his coat collar. . . .

* * *

Reverting to this question of things that are characteristically English, I am reminded of my remarks last week on the differences between American and English life. Our visitors this summer will inevitably be struck by our apparent distaste for central heating, and by our tendency to cling to such out-worn modes of rising in the world as staircases. In this connection I am reminded of the disgusted Englishman who returned from New York full of admiration for non-stop elevators to the twentieth floor, and such like, to find a notice stuck up in the City offices where he had his habitat—"Lift not working!"

* * *

And here is an American tale; it concerns a farmer who was travelling along the road in his flivver when he met an acquaintance from a distant town coming the other way on his wrong side. A collision seemed inevitable, and the farmer hastily pulled out of the way, so that *he* was then on his wrong side as well. The other was surprised, since the farmer had the right of way, and he said so. For reply, the farmer took his acquaintance to the neighbouring cemetery, and pointed to a recent tombstone. The inscription on it ran as follows:—

"Here lies the body of William Jay,
Who died defending his right of way.
He was right—dead right—as he drove along,
But he's just as dead as if he'd been wrong!"

* * *

THIS WEEK'S GENIUS.

The man who first thought of extinct volcanoes as a receptacle for old razor-blades!

Marksman.

# Institute of British Foundrymen.

## ANNUAL BRANCH MEETINGS RECORD CONTINUED PROSPERITY.

### BIRMINGHAM BRANCH.

**Annual Meeting: Lecture on Grinding Wheels.**

Mr. E. H. Tyson was unanimously elected President of the Birmingham, Coventry and West Midlands Branch of the I.B.F. at the annual meeeting held at the Birmingham Engineers' Club on April 25. Giving the report, the honorary secretary (Mr. F. K. Neath) mentioned that the average attendance at the meetings was 37, while the lectures had been of a high standard. The Branch was undertaking the responsibility on May 28 of entertaining the party of American and European visitors who were coming to this country in connection with the London Convention, and funds would be required, towards which several members had promised to double their subscriptions. The junior section continued to do excellent work, keen discussions on various lectures being a most encouraging feature. There were still 23 junior members, but the Branch itself had made a net gain of 16 members. The expenditure for the year was £56 2s. 7d., which left a considerably increased credit balance of £37 7s. 1d. The report was adopted. Mr. F. G. Starr, the retiring President, after thanking the Council and members for their loyal support, proposed Mr. Tyson, who had been junior Vice-President for two years, to succeed him, saying that Mr. Tyson had devoted a good deal of time to the affairs of the Branch and would uphold its traditions. Mr. J. G. Pearce seconded, and in acknowledging his election Mr. Tyson urged members to support the appeal for funds wherewith to entertain their overseas visitors. The new President then moved that Mr. D. Wilkinson be appointed senior Vice-President, which Mr. H. J. Roe seconded; while Mr. Wilkinson proposed that Mr. T. Henry Turner (son of Prof. Thomas Turner) be elected junior Vice-President, Mr. J. B. Johnson being the seconder. Mr. Wilkinson said that by ability, learning and family association Mr. Turner would no doubt commend himself to every member. (Applause.) Both gentlemen were elected, as was Mr. Neath as hon. secretary. Mr. Roe proposed that Mr. Neath be asked to continue, and Mr. D. H. Wood, in seconding, echoed the words of Mr. Starr by saying that the Branch had never had a better secretary. Messrs. E. J. Lewis, W. H. Moore, J. G. Pearce and H. J. Roe were re-elected members of the Branch Council, and additional elections were Messrs. Callaghan, E. S. Morgan and E. Moran. The Council will decide as to their term of office. As delegates to the General Council Messrs. Johnson and Wood were reappointed, and Messrs. Wilkinson and Roe will act with them, Mr. Edwards having resigned. On the motion of Mr. Johnson, seconded by Mr. Wood, the retiring President, together with the Secretary, were heartily thanked for their zealous services.

**Grinding Wheels for Foundry Uses.**

Mr. S. L. Ireland, of the Universal Grinding Wheel Company, Limited, of Stafford, afterwards gave an interesting address on "The Grinding Wheel in the Foundry." Tracing the developments leading to the modern grinding wheel, he said that the first abrasive to be used in the form of a wheel was probably of sandstone. This type was still largely used in the edge-tool and cutlery trades. But owing to the risk which its operation entailed to the health of the worker, the Home Office had recently issued such stringent restrictions that in all probability these grindstones would eventually be discarded almost entirely in favour of the more modern artificial wheel, which was the culmination of much scientific research. In careless or unskilled hands, grinding wheels could do an enormous amount of damage, to avoid which the lecturer gave a series of hints at the close of his remarks. Emery was probably the next abrasive to come into use. It was an impure form of corundum, and a mixture of alumina oxide and iron. It varied considerably, and was therefore not now regarded as the most suitable abrasive for the vast majority of jobs. Dealing with the various processes leading up to present-day wheels, Mr. Ireland referred to the clay-like mineral, bauxite, found in the south of France, which contained a high percentage of alumina oxide. Hence it was of great value as a raw material for the manufacture of alumina abrasives and as a substitute for the natural alumina abrasives of emery and corundum. It was, however, never found in a crystallised state, and consequently had to be first calcined, and then fused in an electric furnace after suitable chemicals had been mixed with the calcined ore. Subsequently the material was reduced to grains, samples of which were shown, as also were the crushed furnace products. This alumina abrasive was extremely hard, very tough, and eminently suitable for grinding steel, malleable iron, and all high tensile metals. During the experiments on artificial abrasives, Edward G. Acheson in 1891 found that by fusing carbon and silicon an extraordinary substance—silicon-carbide, or carborundum—was the result; and to-day salt, sand, coke and sawdust were the raw materials used in the manufacture of this abrasive. Coke supplied the carbon, sand gave the silicon, sawdust made the whole mass porous so as to allow of the free passage of the gases in the furnace, and salt assisted in eliminating certain impurities such as iron, etc. Large furnaces were employed and considerable electric current was required during the 36 hours or so during which the material was treated. The intense heat generated was approximately 4,150 deg. C. Thus electrical energy needed to be produced or supplied at a very cheap rate in order to enable the product to be made and sold as a commercial proposition. This carbide of silicon was now manufactured in several parts of the world, and was the hardest artificial abrasive known. Owing to the fact that it breaks with a peculiar crystalline fracture, it is pre-eminently useful in the grinding of cast iron, brass, bronze, aluminium, and all the low-tensile metals.

Proceeding to describe two of the five main processes of bonding, Mr. Ireland explained the difference between (1) the shellac, and (2) the most important of all, the ceramic or vitrified process. These bondings were chiefly employed in the manufacture of fettling wheels. The shellac process was used very largely in wheels for dressing steel castings on the swing frame machine, and almost exclusively for fettling annealed malleable iron and aluminium castings. It produced a very free-cutting wheel and was also a safe one to use. It was very much tougher than its more brittle confrère, the vitrified wheel. The latter involved a more complicated process, an essential feature being the drying period, in which every particle of moisture must be eliminated before the material was taken to the kiln for vitrification. Too much or too little heat, and heat too rapidly or slowly applied, would result in disaster to several tons of wheels in the kiln, and the same loss would result if the kiln cooled too quickly. As much as six weeks were required to elapse before large kilns were drawn.

Mr. Ireland then took his audience through the factory by means of lantern-slides, and showed the different processes of manufacture. Touching on the leading of the hole, he said that while on some precision grinding machines it was an advantage, it was not essential in the majority of foundry wheels. If a wheel were out of truth and set up vibration, it should be trued up with a dresser, and on no account should a chipping hammer be used. Giving further hints, he said that when correctly mounted the wheel should be allowed to run light for a minute or two. It was inadvisable suddenly to force work against a cold wheel; rapid heating might cause it to crack. The lecturer showed how a wheel should be mounted, pointing out that breakages occurred very largely through incorrect mounting. Too great a variety of work should not be expected from one wheel. If a wheel became glazed or shiny on the cutting surface, it was a sure sign that it was too hard. A man on piece-work usually preferred a comparatively soft wheel, because generally speaking it cut faster than a hard one. Vibration was to be avoided. It might be caused by the machine not being sufficiently rigid, loose bearings, wheel being out of balance, driving belt improperly fitted, and sometimes causes by outside sources transmitted to the machine. The wheel should be run at the speed recommended by the makers. As the wheel wore down its peripheral speed diminished unless the spindle speed was correspondingly increased. In some cases worn wheels could be transferred to another machine with a greater running speed, and so on until it was unusable. It was important to see that the work rest was adjusted close to the wheel, so as to prevent the work becoming jambed between it and the wheel. Wheels used for wet grinding should not be allowed to stand partially immersed, a practice which would throw them out of balance. It was often dangerous to apply undue pressure by grinding on the sides of flat straight wheels, especially if they were thin. If much side-grinding was to be done, it was advisable to instal a ring grinder.

**Discussion.**

Mr. Johnson, proposing a vote of thanks to Mr. Ireland for his lecture on a subject on which he said they could not know enough, recalled that members of the Branch had visited the Stafford works and found them most interesting. Mr. Wood seconded, saying that they had learned a good deal, particularly on the misuse of grinding wheels.

Questions being invited, Mr. Tyson asked if there was any preparation which could be recommended to stop clogging on grinding wheels fettling aluminium. Mr. Ireland explained that two types of wheels were used, the vitrified and the shellac, but silicon-carbide bonded with shellac did not clog as did the vitrified type. It was only with the latter type that any preparation was needed, and then a little tallow candle was sufficient. Mr. Wilkinson inquired as to the need for a dresser in order to secure a true cutting surface. Mr. Ireland pointed out that there was more than one process for making vitrified silicon-carbide wheels used in a cast-iron foundry. Some manufacturers made them under a press, the puddle being put into moulds in a semi-dried state. But it was impossible to get a wheel of any size so truly uniform by this or by the hand-tamped method as by the poured process, which was homogenic. There was a certain amount of risk that a shellac-bonded wheel made under the press would wear out of the true, but a careful and skilful fettler would use his work as a dresser for the wheel. Some men could use a wheel of anybody's make and never required a dresser. With one of the two wheels of a double spindle machine out of the true the mischief would be transferred through the spindle to the other wheel. Replying to Mr. Neath as to grinding white iron, Mr. Ireland said a different type of wheel was necessary than for annealed malleable iron, for which they could not better oxide-of-aluminium bonded with shellac, as it did not

clog, whereas a vitrified wheel would clog. It was desirable to treat white iron as a low-tensile metal, and use a vitrified silicon-carbide wheel of the desired grit and grade.

## SHEFFIELD AND DISTRICT BRANCH.

The annual meeting of this branch was held at the Albany Hotel, Sheffield, on April 19, when Mr. J. T. Goodwin, the retiring president, presided over a large attendance.

Mr. G. L. Oxley, secretary of Messrs. George Oxley & Sons, Limited, Vulcan Foundry, Sheffield, was elected president for the ensuing year; the Hon. J. M. W. North, of the Staveley Coal and Iron Company, senior vice-president, and Mr. C. W. Hampton, director of Messrs. C. & J. Hampton, Limited, Record Works, Sheffield, junior vice-president. Messrs. A. L. Steggles, C. Webster, C. L. Mason, G. C. Castle, and A. Whiteley were elected members of the Council, and Messrs. J. M. W. North, C. W. Hampton, and J. R. Hyde delegates to the General Council. Mr. T. R. Walker was re-elected hon. secretary and treasurer.

Mr. Goodwin gave some details with regard to the International Conference to be held in June. He outlined the tour which the overseas visitors will make from London along the West Coast, to Edinburgh, through Newcastle and through Yorkshire, reaching Sheffield on June 7 and staying till June 8. He said the Master Cutler had interested himself in the matter, and had promised to do all he could to help the branch in connection with the visit. On the morning of June 8 they would all meet at the University, and arrangements were being made for parties to be shown round various works. The ladies would be shown round one or two works of special interest to them. It was expected that the number of visitors to Sheffield would be about 80. As the gathering was an international one, the branch had appealed to all their friends in Sheffield and district to assist them. He was glad to say that many had responded, and he hoped that, by the time the visit was paid, they would have got sufficient funds together to entertain them as foreign visitors should be entertained. It was very important to the trade of Sheffield that they should foster this international feeling. He thought the Institution was out to do its best in order that the visitors might carry away with them a feeling that in this country we had the best goods to offer when they were out to buy.

Mr. F. K. Neath, of the British Cast Iron Research Association, Birmingham, then gave a lecture on "Some Recent Developments in Cupola Design," which, together with the discussion that followed it, will be published in a following issue.

## MIDDLESBROUGH BRANCH.

The annual meeting of the Middlesbrough Branch of the Institute of British Foundrymen was held at the Cleveland Scientific and Technical Institute, Middlesbrough, on April 19, Mr. S. U. Toy presiding.

The hon. Secretary, Mr. N. W. Ridsdale, in his report said that, while there had been no outstanding event during the past year, good and progressive work had been accomplished, and the membership showed a gratifying increase. He pleaded for a greater interest in the branch's activities and an increase in its numerical strength in view of the fact that probably next year the annual convention would be held in Middlesbrough.

Mr. Ridsdale announced his intention of resigning from the secretaryship, and he added that it would not mean that his interest in the branch's work would cease.

Mr. Ridsdale's resignation was accepted with regret.

Mr. T. E. Bashford, the hon. financial secretary, reported a small debit on the season's working, and stressed the need for early payment of subscriptions.

Mr. Toy stated that the council had recommended the election of Mr. Ridsdale as president for the current year in appreciation of his secretarial work, and the meeting unanimously accepted the recommendation.

The other appointments were senior vice-president, Mr. W. Shaw; junior vice-president, Mr. A. G. Harrison; hon. secretary, Mr. F. A. Harper; hon. financial secretary, Mr. T. E. Bashford; members of council, Messrs. C. B. McCusker; J. E. Mercer and T. Walker; delegate to General Council, Mr. S. P. Thorpe.

## LONDON BRANCH.

The annual general meeting of the London Branch of the Institute of British Foundrymen was held at the Engineers' Club, W., on April 18. In the unavoidable absence of the President (Mr. W. B. Lake) through illness the chair was taken by Mr. J. W. Gardom, Senior Vice-President.

In presenting his annual report the hon. secretary and treasurer (Mr. H. G. Sommerfield) said that the year under review was one of further progress and would, he was sure, give satisfaction to their own particular members as well as to the Institute generally of which they were a part. Their membership stood at 247 as compared with 228 a year ago. That figure of 247 had taken into account all resignations, deletions and transfers from the branch register and, of course, members added. The membership was divided as follows:—Members, 144; Associate Members, 91; and Associates, 12. He regretted to report the death during the year of Messrs. A. S. Hider, A. C. Johnston and W. J. Laidlow. The monthly lectures had been well attended, and the subjects for discussion had invariably proved interesting and instructive. Seven lectures had been given during the session, and he would like to express his thanks both to Mr. Delport and Mr. Dews for the great interest they had shown in the branch by preparing and presenting papers in difficult circumstances. The joint meeting with the London section of the Institute of Metals was held that year under their own auspices. Mr. Deeley was the lecturer. Owing to arrangements that had to be made for works visits during the approaching International Congress they would appreciate the reason for the exclusion of any visits during the session. The invitations extended during the conference period would, of course, be open for London members as well as for others.

He was pleased to report continued financial improvement. The balance in hand at the end of the financial year was £122 5s. 11½d., as against £98 4s. 2d. at the end of 1927. The Social Fund had a balance in hand of £85 13s. 8d. The success of the coming conference in London to which he had already referred would depend largely upon the support given by their own members. Visitors were expected from the U.S.A. and many Continental countries, and the Council hoped that every member of the branch would assist to his utmost in seeing that this third triennial congress in London was a memorable one. The Council had re-elected Messrs. Bartlett and Cleaver as Hon. Auditors, and had placed on record the thanks of the branch for their services during the past year.

The Chairman, in moving the adoption of the report, said he did not think anyone could find much fault with it. The branch was more successful than it was two years ago, and they were sorry that Mr. Lake was not there to receive thanks from them. They should be very much indebted to Mr. Sommerfield for the work he had done. He appealed to them for support during the coming conference.

Mr. Herring seconded, and the report was unanimously adopted.

The following officers were elected to serve during the ensuing year:—President, Mr. J. W. Gardom; senior vice-president, Mr. A. F. Gibbs; junior vice-president, Mr. H. C. Dews; hon. secretary and treasurer, Mr. H. G. Sommerfield. Mr. H. S. Clark and Mr. F. J. Cree were re-elected on the Council, and Messrs. Delport and Beech were elected to fill vacancies. On the recommendation of the branch council Messrs. Lake, Bagshawe, Dews, Cree and Wares were elected to serve as delegates on the General Council.

The Hon. Secretary having outlined the preliminary arrangements for the coming conference, a vote of thanks was accorded the officers of the branch for their services during the past year.

On behalf of Mr. Lake and the other officers, the Chairman returned thanks.

## LONDON JUNIOR SECTION.

The London Junior Section held its annual general meeting in the offices of The Foundry Trade Journal, 49, Wellington Street, London, W.C.2, on April 26, Mr. F. C. Cummings presiding.

### Election of Officers.

The following officers were appointed for next session: Chairman, Mr. H. R. E. Slater; Vice-Chairman, Miss M. D. Pittuck; Hon. Secretary, Mr. J. P. Ellis (re-elected); Members of Council, the following were re-elected: Messrs. B. B. Kent, F. Perry and V. C. Warren, in addition to two new members, namely, Mr. J. Butler and Mr. L. H. Howell.

### Vote of Thanks.

A unanimous vote of thanks was passed to the retiring Chairman, Mr. F. C. Cummings, and the officers, for their work during the session, particular reference being made to Mr. Ellis' valuable work as Secretary of the Section.

A very hearty vote of thanks was also accorded to the Proprietors of The Foundry Trade Journal for their continued kindness in allowing the London Junior Section to hold its meetings in their offices. The Chairman said that they all appreciated this privilege, and also to Mr. V. C. Faulkner and Mr. H. G. Sommerfield for their interest and support.

### Competition.

Mr. A. F. Gibbs, who was present at the meeting, kindly offered a prize to the member of the London Junior Section who gave the best Paper during the coming session. He suggested that this would have to be judged from a total of seven papers, and that there should be an age limit. Arrangements were left in the hands of the Hon. Secretary.

### Visit to National Physical Laboratory.

The Junior Section next meets on May 25, when a visit will be paid to the National Physical Laboratory, Teddington.

**Cutting Speed for Chilled Rolls.**—According to data compiled by a large rolling-mill-machinery builder in the United States, the cutting speeds used on lathes vary widely in different shops. What is considered good average cutting speed in one shop is considered too slow or too fast in another shop. It also varies on different classes of work. Some shops consider the proper speed for cutting chilled rolls 35 to 38 in. per minute, while others go as high as 70 to 80 in. a min. The following are good average cutting speeds in inches per min.:—Sand iron or steel, 300 to 336; alloy (hard, 2.40 per cent. carbon), 55 to 60; chilled, 48 to 50. The foregoing cutting speeds are high for sand iron and steel rolls and are rarely used except in roll-makers' foundry roll shops where the turners are paid piece-work. The piece-work system of turning rolls is used almost exclusively by the roll-makers, as their work consists largely of turning necks and rough body turning, and there are few other shops where tool steel receives the same abuse.—"Iron Trade Review."

# Chilled Castings.

## CHARACTERISTICS AND POSSIBILITIES OF APPLICATION.

By Hans Bator.

Gruson, the founder of the firm Krupp-Grusonwerk in Magdeburg, was the first in Germany to carry out—in the fifties of last century—an extensive series of systematic tests, with the view to improving and perfecting the process of chill-casting, not only in regard to the hardness of the finished product but also in regard to its strength. That he was successful is evidenced by the increasing demand for high-quality chilled castings since that time, in Germany and elsewhere.

The requirements demanded of chilled castings at the present day are extremely varied. Maximum hardness is called for, and also medium hardness, whilst the surface requirements may be coarse or smooth and polished. According to the purpose for which the finished casting is required and, consequently, the depth of the "chill" required, so must the degree of hardness vary. This depth may range from about 3 mm. up to about 50 mm. ($\frac{1}{8}$ in. to 2 in., approximately), and it is possible to regulate the degree of hardness to suit practically any required conditions. In every case, however, the chief quality demanded is an absolute maximum resistance to wear, and this is ensured by imparting great hardness.

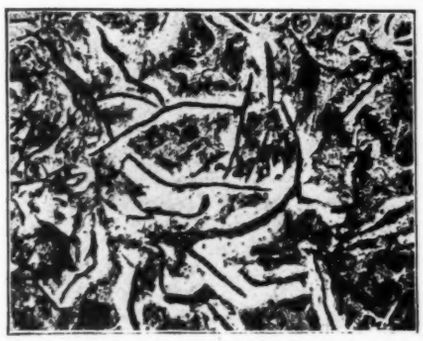


Fig. 1.—Structure of a Machinery Casting.

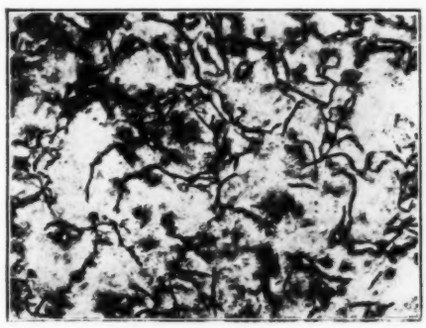


Fig. 2.—Structure of Casting of Normal Strength.

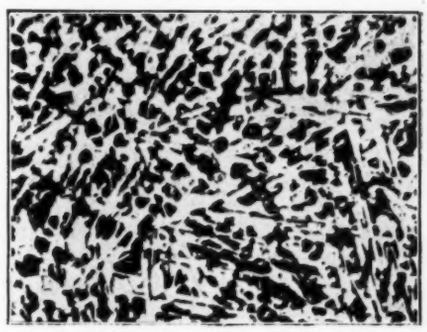


Fig. 3.—Section of a Chilled Casting.

### Characteristics of Chilled Castings.

In high-quality chilled castings, transition of the hard-white surface layer into the soft-grey iron occurs in radiating lines and occurs very gradually. This hard layer, which appears white in fracture, is brittle and capable of withstanding only a small tensile or transverse stress. In order that the finished product shall possess the requisite resistance to fracture, in addition to resistance to wear, the white hard case should only form a certain part of the whole casting, the remainder of which must consist of grey-ductile cast iron. Castings having a hard skin, the depth of which ceases abruptly, are decidedly not of first-grade quality. The structure of such castings fails to meet the requirements which one expects of this form of casting, because the hard zone, which as already stated passes directly to the soft grey layer, fractures in most cases when the casting is stressed under actual working conditions.

Chilled castings of the type under discussion are generally cast from either cupola or reverbatory furnaces, and of late also from electric furnaces. It may be stated in this connection that according to the particular use for which the casting is intended, so each process offers special advantages.

### Selection of Materials.

The composition of a suitable carburising material for high-grade chilled casting necessitates a thorough knowledge of the properties of the individual brands of pig-iron, on the correct selection and quantity of which depends the attainment of the specified requirements in the finished product. In this respect, analysis is undoubtedly of great assistance to the foundry manager. It is not sufficient, however, that attention should be directed only to the proper selection and volumetric proportioning of suitable kinds of iron; the hardness of the casting is dependent upon numerous other factors. The thickness of the chills, their temperature, and the speed of cooling exercise a very powerful influence on the quality of casting produced.

The temperature of the melting bath in the furnace and also in the mould and during the actual casting must be carefully supervised and controlled if the best results are to be obtained. In the manufacture of hollow bodies, such as rolls or press pistons, plungers, rams, etc., the cores used also exercise a decisive influence on the success of the casting. Cores should not be used which are not thoroughly dry and uniformly dense. Even the temperature in the foundry may adversely affect the casting at the last moment and result in a faulty casting, especially in winter. The success of a good chilled casting depends not only on the observance of the metallurgical influences; even to-day it is not possible to determine by measurement and calculation all the factors necessary to ensure success. Therefore, in spite of all the attempts made to study and outline scientifically the various stages occurring in the manufacture of chilled castings the experience of the practical man is indispensable.

### Importance of Analysis.

Carbon, silicon and manganese, all three of which are essential for proper hardness, must be represented in definite volumetric proportions in a good chilled casting. Thorough research into the qualities and properties of the pig-iron in use as well as of the coke used by daily works analysis are understood prerequisites for a well-run plant. No ladle should leave the furnace without proper examination of its contents. When the ladle is full, its contents must be well stirred and test-pieces cast. These should be cooled by air and water and then broken into fragments. The appearance of the resulting fracture of such test-pieces gives a very practical and adequate idea of the hardness and depth of chill to be expected from the casting. Small deviations from the desired quality may be rectified by the addition of either soft or hard carburising composition. If the deviations from the required standard are considerable, the cast will be worthless. If, however, everything is found correct, then the ladle so tested may be

Fig. 4.—Showing Incorrect Change from Chilled Zone.

Fig. 5.—Fracture and Ground Section of Correctly Chilled Casting.

released for pouring, with instruction at the same time as to whether it is to be cast hot, warm or flat.

Hand in hand with the checking just outlined, which should be carried out during the actual work, constant supervision of quality must be exercised in the laboratory, where, amongst other duties, metallographic examination of the castings should be conducted. These pertinent examinations should not only extend to test-pieces, but also to the casting itself, where, in special instances, it is deemed necessary that such metallographic examination be undertaken prior to delivery to the consumer. Micrographs also render invaluable service in the perfection of chill casting.

### Hardness Determination.

Hardness of these castings is generally measured by means of the Shore, Brinell, or the Schwarz methods. In this connection it should also be remembered that the hardness of a chilled casting increases if it is required to work against heavy pressure for any length of time. The surface layer becomes highly compressed—a point to be considered with fresh consignments. Fig. 1 shows the structure of a good machine casting. The rather pronounced black streaks are graphite veins or flakes, which are embedded in a white ground mass of so-called ferrite (pure iron). To a lesser extent may be seen a third constituent, pearlite. The two principal constituents, however, graphite and ferrite, are very soft bodies. Castings of this type are easily machined. The hardness amounts to about 30 Shore and 130 Brinell. With such a mild material, resistance to wear is naturally very low.

Fig. 6.—Fracture showing Gradual Change from Chilled Zone.

Fig. 8.—Chill-Cast Roll ready for Fettling.

### Characteristic Structures.

This resistance, however, is higher in the case of the pearlite iron (Fig. 2). In this example the long, rather broad graphite veins have disappeared, and in their place is seen finely foliated or veined graphite; ferrite is absent, being superseded by the ground mass of pearlite. This pearlite consists of a microscopically fine mixture of ferrite and cementite. Pure cementite possesses great hardness. As a matter of fact the hardness of such a casting amounts to about 40 Shore and 200 Brinell. Its resistance to wear, on the other hand, is higher than in the case of ordinary machinery castings. It attains maximum value only in the form of chilled castings, the structure of which will be noted from Fig. 3, in which graphite and ferrite have totally disappeared; the hard structural constituent cementite is found in a free form embedded in a ground mass of pearlite as small needles. Fig. 4 shows the appearance of a fracture and also the ground surface of a test-bar of a chilled casting, about 2 in. thick and with a depth of hardness or chill of about ½ in. to ⅝ in.

Fig. 5 shows a fracture and ground surface of same, in respect of a particularly good specimen, in which, it will be at once seen, the extra depth of hardness and also what is of great importance—how intimately the hard white layer is united with the softer grey of the casting by the remarkably good penetration.

It will be understood, from a study of these illustrations, that one of the chief requisites of a good chilled casting is that the white hard layer must merge into the softer grey portion not only very gradually but also in finely penetrating and slightly radiating lines.

Fig. 6 shows again a chilled casting in which the transition of the hard into the soft layer is gradual. The piece represented is a rim fracture of a chill-cast car wheel.

### Varied Application.

As a result of the excellent qualities which chilled castings possess in general with regard to resistance to wear, they are employed to a wide extent throughout industry for such highly-stressed products as rolls.

Yet again, chilled casting is the obvious and correct material for all machine parts which are subject to heavy duty, such as the wearing parts of crushing machines (*e.g.*, jaws, roll shells, etc.), also pressure and press plates, straightening, forming and marking plates, drawing rings, the working parts of dredgers, capstans, car wheels, bearing rollers, guide rollers, wheel sets for railway rolling stock, and numerous other applications.

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**Stainless Iron Plates.**—A plate which is believed to be the largest ever manufactured in stainless iron has been rolled by Messrs. David Colville & Sons, Limited, at their Dalzell Steel and Iron Works, Motherwell. The dimensions of the plate are 16 ft. 10 in. by 70 in. by ⅛ in. The product is the result of extensive research carried out in the works.

## Position of Light Castings Trade.

Colonel A. D. McInnes Shaw, M.P., of Messrs. Shaw & McInnes, Firhill Iron Works, Glasgow, speaking at Polmont recently, said:—The light castings industry in this country was up against a very serious position. Rain-water goods were brought into this country from France to be sold here. France kept a big stock of such goods in this country, and they were sold here at prices ranging from 17s. to 26s. a ton cheaper than they could be manufactured in Scotland. Under such conditions the trade was seriously handicapped. He said that the conditions of labour in European countries was so positively different from those prevailing in this country that it would be necessary to protect the interests of the workers in this country. The only way to reduce the number of unemployed workers was to get men back to their old jobs and to get the cost of manufactured articles down to a selling proposition in the markets of the world.

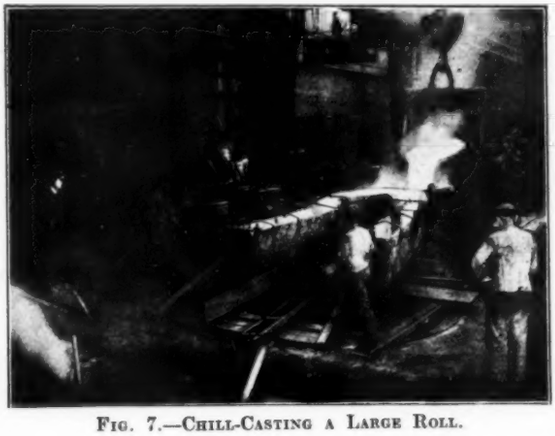

Fig. 7.—Chill-Casting a Large Roll.

## Contracts Open.

**Guardbridge, Fife,** May 11.—Water main, for the St. Andrews District Committee. Messrs. Bruce & Proudfoot, civil engineers, 63, Nicol Street, Kirkcaldy. (Fee £1, returnable.)

**Newbury,** May 16.—23,410 yds. of cast- or spun-iron pipes, for the Corporation. The Borough Water Engineer, 18, Cheap Street, Newbury.

**Johannesburg,** June 20.—Two 5-ton electrically-driven hoist blocks, complete with overhead conductors, runway girders and switches, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference A.X. 7,867.)

**Johannesburg,** June 20.—One 10-ton and three 4-ton electric level luffing cranes, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference A.X. 7,828.)

**Uruguay,** May 22.—Four electric cranes, mounted on trucks, for the National Administration of the Port of Montevideo. The Department of Overseas Trade. (Reference A.X. 7,814.)

**Wellington, N.Z.,** August 6.—One 120-ton four-motor overhead travelling crane and runway, for the New Zealand Public Works Department. The Department of Overseas Trade. (Reference A.X. 7,810.)

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The purchaser of the spring-manufacturing departments of the works of Messrs. J. Spencer & Sons, Newburn-on-Tyne, is Mr. Leslie Barlow-Massicks, who proposes to form a private limited company, of which he will be the managing director, to restart the spring shops and, as trade improves, to develop the works still further. The purchase includes the laminated spring shop, volute and spiral spring shops, smiths' department, testing houses and offices, covering an area of about seven acres. Mr. Barlow-Massicks has been associated with Messrs. Steel, Peech & Tozer, Limited, Rotherham, for some years, and at present is sales manager for the whole of the products of the company. It is stated that Mr. Eric Frost, at present manager of the spring department of Messrs. Steel, Peech & Tozer, Limited, will be works manager at the Newburn works.

# THE IRON AND STEEL INSTITUTE.

## ANNUAL MEETING IN LONDON.

The Annual Meeting of the Iron and Steel Institute was opened last Thursday at the Institution of Civil Engineers, Great George Street, Westminster. At the outset, the retiring President (Mr. Benjamin Talbot) occupied the chair.

### Report of Council.

The Council of the Institute, in their report for the year 1928, state that during the year 124 new members and 5 associates were elected; 8 associates were transferred to membership, and 5 members were reinstated. Sixty-three members resigned their membership during the year, and the names of 25 members were removed from the register owing to the non-payment of their subscriptions. The total membership of the Institute on the register on December 31, 1928, was accordingly as follows:—Patron, 1; honorary members, 5; life members, 77; ordinary members, 1,911; associates, 14; total, 2,008. In the past year Conde de Zubiría, of Bilbao, was elected an honorary member. The Council have also elected Mr. Alfonso de Churruca, of Bilbao, an honorary Vice-President of the Institute. It is satisfactory to record that there is an increase of 25 in the total membership as compared with 1927.

The deaths of 21 members occurred during the year, and the Council specially wish to place on record their sense of the great loss to the Institute incurred through the deaths of Mr. Andrew Lamberton, who had served on the Council since 1905, and was elected a Vice-President in 1914; Mr. E. Mayrisch, President of the Aciéries Réunies de Burbach-Eich-Dudelange in Luxemburg; Dr. E. Schrödter, the well-known General Secretary (retired) of the German Society of Ironmasters, who on two occasions acted as Hon. Secretary of Autumn Meetings of the Institute in Germany; and Mr. F. Timmermans, who was a member of the Reception Committee which entertained the members on the occasion of the Brussels Meeting in 1913.

*Finance.*—The income for the year, apart from that of the Carnegie Scholarship Fund and of the Special Purposes Fund was £7,940, and the expenditure was £7,918, as against £7,831 and £8,710 respectively in 1927.

*Andrew Carnegie Research Scholarships.*—On the recommendation of the Carnegie Research Committee, grants were made by the Council during the year to the following candidates:—

David Binnie (Glasgow), £100, to assist him in continuing his research work under Professor J. H. Andrew at the Royal Technical College, Glasgow, on behalf of the Heterogeneity Committee, the subject being the determination of the liquidus and solidus of carbon and alloy steels, and a study of reactions of sulphides in liquid and solid steels.

B. S. Smith (Sheffield), £100, to assist the continuation of his research work under Professor C. H. Desch, F.R.S., at Sheffield University on behalf of the Heterogeneity Committee, the subject being the viscosity of molten steel.

Henry Temel (Kladno, Czecho-Slovakia), £50, in aid of a research on the sulphur contents in slag of the open-hearth process.

Joseph Vietorisz (Budapest), £50, in aid of an investigation on the properties of malleability of rolled or hammered iron and steel.

*Changes on the Council.*—Mr. John Craig, C.B.E., has been elected a Vice-President, and Mr. E. J. George has been elected a Member of Council. In accordance with Byelaw 10, the names of the following Vice-Presidents and Members of Council were announced at the Autumn Meeting as being due to retire at the Annual Meeting, 1929:—Vice-Presidents: Mr. E. H. Saniter; Colonel Sir W. Charles Wright, Bt., K.B.E., C.B.; Mr. M. Mannaberg. Members of Council: Mr. A. Dorman; Dr. W. H. Hatfield; Mr. V. B. Stewart, C.B.E.; Mr. H. Spence Thomas; Mr. A. O. Peech. No other members having been nominated up to one month previous to the annual meeting, the retiring members, in accordance with the announcement made at the Autumn Meeting, are presented for re-election.

Prof. Henry Louis, M.A., D.Sc., A.R.S.M., M.Inst.C.E., F.I.C., F.G.S.

*(President of the Iron and Steel Institute).*

Professor Henry Louis, who is Secretary of the North of England Institute of Mining and Mechanical Engineers, Emeritus Professor and late Professor of Mining, and William Cochrane Lecturer on Metallurgy at Armstrong College, University of Durham, was born in 1855. He was educated at the City of London School, became Government Exhibitioner, Science and Art Department, and entered the Royal School of Mines in 1873. He was engaged in iron and steel works in Nova Scotia, Swansea, and near Edinburgh, and later had experience in gold mining in South America, West Africa, South Africa, and many other parts of the world. He is President of the Institution of Mining Engineers, and Vice-President of the Institution of Mining and Metallurgy; a member of the Institute of Metals, and a Past-President of the Society of Chemical Industry. Professor Louis is the author of numerous books and other publications on mining and metallurgical subjects.

### Greetings from Mr. Charles M. Schwab.

The President read the following message from Mr. Schwab:—

"Please convey my congratulations to your Iron and Steel Institute upon their Diamond Jubilee, and also my good wishes to the gentlemen who have for so long been identified with it. I also send you these greetings as President of the American Iron and Steel Institute, for your kindly attitude to me still remains a warm and happy memory, which I shall always retain. With best wishes for a delightful and a successful meeting, I am, Yours sincerely, Charles M. Schwab."

### Induction of Newly-Elected President.

The President said he now had the pleasing duty of inducting his successor, Prof. Louis, into the chair. Prof. Louis was of international reputation. As a young man he went through the puddling furnaces, the blast furnaces and also worked at the steel furnace. Some of the other members did the same thing, and they certainly obtained experience and, possibly, physical development at the same time. He was sure that Prof. Louis would receive not only the help of the Council but of the individual members, and that he would have a very successful term of office.

The chair was then vacated by Mr. Talbot and taken by Prof. Henry Louis.

Sir W. Peter Rylands, J.P. (Past-President), in moving a vote of thanks to the retiring President for his services to the Institute during the past year, said it had been very pleasing to all of those keenly interested in the steel trade that Mr. Talbot should have occupied the chair during the past year. Of all the Presidents of recent years he did not think there was one who had been quite so actively connected with the practical technical advancement of works practice in the steel trade as Mr. Talbot. The members desired to thank Mr. Talbot for his services and for the distinction and lustre that he had added to the office of President, which had been handed down to him from very many distinguished predecessors.

Mr. Frank W. Harbord, C.B.E. (Past-President), formally seconded the resolution, which was carried by acclamation.

Mr. Benjamin Talbot, in thanking Sir Peter Rylands for the all too kind words he had used in reference to his services to the Institute, remarked that his work during the past year had been a labour of love and he had enjoyed every minute of it. The Council and the individual members had been very helpful to him and had made his work exceedingly easy. He thanked the members most sincerely for the cordial manner in which the resolution had been passed.

### Presentation of the Bessemer Gold Medal.

The President (Prof. Louis) said the first official task allotted to the position to which the members had been good enough to elect him was the extremely agreeable one of presenting the Bessemer Gold Medal of the Institute to his distinguished fellow-townsman Sir Charles Parsons. It was a curious coincidence and peculiarly appropriate that on the Diamond Jubilee, the 60th Anniversary of the foundation of the Institute, which had its origin in Newcastle-on-Tyne, the highest distinction which the Institute had in its power to award should go to a man whose work had been connected with Newcastle-on-Tyne. In such an assembly it was entirely unnecessary to attempt to enumerate the very large number of services which Sir Charles had rendered to every branch of technology. The brilliant work that Sir Charles Parsons had done had naturally brought him many, indeed he might even say most, of the

distinctions that any man in his profession could covet; but he ventured to think that, having regard to the long list of eminent men to whom the Bessemer Medal had been awarded in the past, even Sir Charles Parsons might take a pride in adding his name to so distinguished a roll, and the Iron and Steel Institute was certainly very proud that Sir Charles' name should appear upon it. It was unnecessary for him to say more on such an occasion, and it therefore only remained for him to hand Sir Charles Parsons the Bessemer Gold Medal, and to express the cordial wish that he might hold it, together with his many other numerous distinctions, for very many years yet to come.

The President then presented the Medal to Sir Charles Parsons.

Sir Charles Parsons, K.C.B., F.R.S., said he very much appreciated the honour of receiving the Bessemer Gold Medal, but he asked the members to associate in their minds another person also, Mr. H. M. Duncan, who had done most of the work in developing the suggested new process. A great deal of the credit for the work of adapting the process to steel was due to Mr. Duncan, and he therefore accepted the Medal with the association in his mind of the work that Mr. Duncan had done.

## Presidential Address.

At the outset Prof. Louis expressed his very heartfelt thanks for the honour that had been done him in electing him President of the Institute. It was no light task to endeavour to tread in the footsteps of the long line of illustrious men who had preceded him in the presidency of the Iron and Steel Institute. Prof. Louis recalled the fact that it was fifty years ago that he read his first Paper before it at a meeting made memorable by the fact that it was the occasion when Messrs. Gilchrist and Thomas communicated to the members of the Institute the epoch-making process which they had invented.

The changes which that half-century had wrought in the manufacture of iron and steel would of themselves present a fascinating theme, but he proposed to take a much wider range, and to put before the members a short summary of the history of iron manufacture from its very beginning, viewed in the special light in which he ventured to regard it—namely, as a consequence and corollary of the ever-increasing power which mankind gradually learnt to exercise over the production of heat. He hoped to be able to show that the history of iron and the history of heat generation had gone hand-in-hand throughout the ages, and that the former had been absolutely dependent upon the latter.

### Earliest Use of Iron.

The date, and even the place, of the first use of iron by mankind (continued the speaker) have never been determined; it appears to be generally held that it was first produced in workable quantity on the southern flanks of the Caucasus, and the date assigned is usually somewhere about 3000 B.C. It is, at any rate, certain that, before iron came into use, the metallurgy of bronze was already highly developed. Articles of bronze of the Later Bronze Age show that the art of bronze-founding had already reached a high stage of perfection. The art of making cored castings was undoubtedly known, and it seems probable that even the *cire perdue* process had been invented. No doubt the simple reduction of metallic iron from its ores would have been well within the capabilities of these primitive metallurgists, but from the simple reduction of the metal to its fashioning into any useful form is quite a far step.

Fig. 1.—Blowing up the Fire by the Mouth Blowpipe (Egypt).

Oxide of iron is reducible to the metallic state at a very low temperature, not exceeding 500 deg. C., but the iron so produced is more or less pulverulent and useless for all practical purposes. To weld it into a coherent mass capable of useful application requires not only a considerably higher temperature, but for articles of any size a considerable body of heat. The only information that we have as to the early means of producing the necessary heat is derived from Egyptian mural paintings. It is significant that all the earlier ones—for instance, one from the frescoes of Beni-Hassan (Fig. 1), said to date from about 2500 B.C.—show men blowing up a fire beneath a crucible by means of mouth blowpipes made of reed and tipped with clay, and it is evident that with such rudimentary appliances only very small pieces of iron could be produced.

In corroboration, it may be pointed out that at these very early times iron was evidently looked upon as a scarce and valuable substance; in the Swiss lake dwellings, and at Hallstatt, in Austria, articles of bronze have been found inlaid with iron, thus indicating that the latter metal was the more valuable of the two. The date of the Hallstatt articles is usually given as between 1000 and 875 B.C. The Crown Prince of Sweden, in his recent excavations at Nauplia, on the Bay of Tolon, Greece, found a silver ring in which was set a seal made of iron; this was found in a tomb together with a bronze dagger and other bronze articles, the date assigned being about 1100 B.C. The first known representation of any mechanical means for producing a blast is from the walls of a tomb of the period of Thothmes III, supposed to be from about 1500 B.C.

Sir Charles Algernon Parsons, K.C.B., O.M., C.B., M.A., LL.D., D.Sc., F.R.S.

(*Bessemer Gold Medallist.*)

Sir Charles Algernon Parsons, who is chairman of C. A. Parsons & Company, Heaton, Newcastle-on-Tyne, the Parsons Marine Steam Turbine Company, Limited, and other companies, is a Fellow of the Royal Society, a Past-President of the British Association, Institute of Physics, and the North-East Coast Institution of Engineers and Shipbuilders, and an Hon. Fellow of St. John's College, Cambridge. He is a J.P. and was High Sheriff for Northumberland in 1898.

### Primitive Bellows 1500 B.C.

This primitive bellows (Fig. 2) apparently consists of a flat pot covered with skin, in the centre of which is cut a hole that can be closed at will by the heel of the operator, which thus forms a valve, the skin, when released by the heel, being pulled up by a cord in the worker's hand. It is interesting to note that this identical type of bellows is still used in India by certain tribes for the purpose of iron manufacture, the only improvement in over 3,000 years being the use of a couple of light bamboos which act as springs to pull up the hide cover.

Various other forms of bellows are also in use in different parts of India, and it is certain that a furnace urged by such bellows can be used for reducing iron from its ores in masses of workable size. Some authorities maintain that iron was used in Egypt for industrial purposes before 2500 B.C., but even if this were correct, it would be only in quite small pieces. In any case, it could not have been much used before some means of readily producing the required blast had been devised; so far, all that can be said definitely is that such invention must have been prior to 1500 B.C., but no one can say how much earlier, though it does appear probable that it may have taken place between the years 2500 B.C. and 1500 B.C.

The position at a tolerably reliable date can be well estimated from the British Museum excavations at Djerabis, on the Euphrates (the Carchemish of Biblical times); as recorded in 2 Kings xxiii, 29, and elsewhere in Biblical writings, this place was attacked and captured by Nabuchodnosor, King of the Babylonians, in 604 B.C. The finds consisted of broken swords and spear-heads, all of bronze, and of numerous arrow-heads, both of bronze and of iron; there was also found a beautifully-finished bronze mould for casting the bronze arrow-heads, and it is particularly noteworthy that these bronze arrow-heads are far superior in execution and finish to the iron ones—the iron ones being all tanged, whilst most of the bronze arrow-heads are socketed. The fact of finding the bronze mould is clear evidence that bronze arrow-heads were used by the defending force—that is, the Egyptians—though it is impossible to say that they did not also use iron ones; neither is there any definite evidence as to the type of arrow-head used by the Babylonians, who may have had either bronze or iron, or both, as far as the evidence from the finds goes.

It is, therefore, evident that at this date, even in the centre of the highest civilisation of the time, skill in working iron had not reached anything like so high a level as that of the bronze-worker; the finds are, of course, not conclusive evidence that no larger weapons of iron were in use at the time; the conclusion may fairly be drawn that they must have been far scarcer than the bronze weapons, and that the difficulty of

Fig. 2.—Earliest Known Form of Bellows (Egypt).

*a*, *b*, *k*, *o*, leather case. *c*, *e*, *l*, *n*, pipes conveying the wind to the fire. *d*, *m*, fire. *h*, *g*, charcoal. *k* and *o* are raised as if full of air.

working even moderately large pieces of iron had by no means been fully overcome, and that, whilst small articles of iron could be made readily enough, there must still have been difficulty in producing the larger articles which required a considerable body of heat.

This emphasises the essential point which it is desired to make, that the means of generating the requisite heat must have been the controlling condition in the manufacture of iron. Furthermore, as is well known, whilst iron reduced at a low temperature, even from impure ores, is sufficiently pure not to be brittle, it must necessarily be very soft, and it may readily be supposed that a well-made bronze sword was for quite a while superior to a soft-iron one. This difficulty must have persisted until a much later date in Northern Europe, since the Norwegian Sagas more than once record that a warrior had a sword so soft that he had to stop to straighten it underfoot in the course of the conflict. It would appear to be probable that a good deal of the earlier iron made in Northern Germany and Scandinavia must have been reduced from bog iron ores; these ores are usually high in phosphorus, and the reduction must have taken place at quite a low temperature and, therefore, have produced a very soft iron.

On the other hand, it is quite certain that in the countries bordering on the Mediterranean, where the knowledge of metallurgy was much older and civilisation was much further advanced, temperatures high enough to cause some carbon to combine with the iron and thus make relatively low-carbon steel or steely iron had been attained at a very much earlier date, as is evident from the oft-quoted passage in Homer's "Odyssey"; from this it is obvious that steel or steely iron capable of being hardened by quenching was known in Homer's time, though the carbon content could not have been excessive, seeing that the metal so treated was not too brittle to prevent its being used as an axe; yet there must have been enough carbon present to cause perceptible hardening by quenching, seeing that Homer states that such quenching gives strength to the iron. On the other hand, Homer's frequently-repeated epithet for iron "wrought with much toil" shows that the manufacture of iron was still in an elementary stage; it will be remembered that Homer certainly wrote before 800 B.C.

### Early Production of Steel.

It could, however, not have been very long after the beginning of our era before, with the employment of larger furnaces and, therefore, the production of a greater body of heat, a true steel was produced, and this would, of course, be the case more readily when manganiferous ores happened to be employed instead of ordinary iron ores. Thus both Horace and Ovid refer in their poems to the high quality of Noric iron. The Noric kingdom corresponded to the region now known as Styria and Carinthia, and it is quite probable that this Noric iron was made from manganiferous spathic iron ores of the Styrian Erzberg of Eisenerz. Jars, who visited the Erzberg in 1758, calls attention to the fact that steel was readily produced by smelting certain of these ores. Similar ores appear also to have been worked in Spain, and they, too, must have produced steel or steely iron, and we have evidence that some, at any rate, of this material consisted of iron combined with sufficient carbon to be capable of being appreciably hardened by quenching. It must be remembered that the above statements as to the use of iron refer only to the region which at that early date was the centre of human civilisation; it is generally held that iron was not introduced into Britain until 500 B.C., and that its manufacture did not commence in these islands until about a century later.

### Iron Manufacture in Great Britain.

Before Cæsar's invasion, iron was certainly being made in the South of England, though the Brigantes in the North appear still to have been in a Stone Age. Before Cæsar's time iron currency bars were in use in Southern Britain—a fact which would seem to imply that, although iron was being made, it was still scarce and comparatively valuable. After Britain had become a Roman province, iron was made at numerous places in this country, most actively perhaps in the Forest of Dean, though there were various other important centres of early Roman iron production. The manufacture of iron continued in this country throughout the Roman occupation.

The largest mass of Roman iron found in this country, if not in the world, is the mass discovered at Corstopitum, near Corbridge, in

PROFESSOR A. BRAMLEY, D.Sc.(Lond.), A.R.C.S., D.I.C., F.I.C.

*(Carnegie Gold Medallist).*

DR. A. BRAMLEY received his early scientific training at the Municipal Technical College, Halifax, where he obtained a National Scholarship with which he entered the Royal College of Science, South Kensington. After three years at the Royal College of Science he obtained the Associateship, and also graduated B.Sc. (London University). After specialising in Physical Chemistry and acting as a Research assistant, he gained the Associateship of the Institute of Chemistry and the Diploma of the Imperial College of Science and Technology. Next he gained the D.Sc. for a thesis on "Some Properties of Binary Mixtures." During the war he was in charge of an explosive factory in the North of England. In 1919 he joined the staff of the Loughborough College, where he was ultimately appointed chief of the Department of Pure and Applied Sciences.

Northumberland, described by Sir Hugh Bell. Its date is considered to be between A.D. 350 and 380, and its weight was about 3 cwts. It is interesting to note that the famous iron pillar of Kutub, near Delhi, dates from about the same period or a little earlier, but weighs no less than some 6 tons, so that at that date the Eastern iron-makers were far ahead of their Western contemporaries. There is, however, no doubt that both of these masses of iron were produced by the same method, that of making relatively small lumps of iron by the direct process and welding them together.

It is quite clear that the method of iron production throughout all this period was always the same—namely, direct reduction by charcoal in furnaces probably not more than 3 ft. or 4 ft. high, and blown by bellows worked by man-power, in which the temperature was only high enough to produce soft malleable iron, or, at the best, with suitable ores a steely iron or a steel. Apparently this method of iron-making must have continued during the next thousand years or so; probably furnaces were steadily increasing in size, larger lumps of iron were being made, and probably steely iron or even steel was produced at will. The art of letting down or tempering steel must also have been discovered, and the technique of iron-working, as distinct from the extraction of iron, made immense strides.

### Mechanical Production of Blast.

An invention that must have contributed no little to the increase in the size and power of the mediæval furnace was that of mechanical blast production. Agricola, whose well-known work is dated 1556, though he himself died in the previous year, figures and describes in much detail the construction of a bellows with valves of quite modern type, worked by a water-wheel, and it is obvious from his description that the appliance was old enough for its details to have become standardised. It is on record that such bellows were in use at Göllnicz in 1435. A natural result of the increase in the height and power of the furnace and of the attendant higher heats thus generated was the production of white cast iron, and it is tolerably clear from Agricola's writings that this was known in his day.

No doubt this unexpected result of the higher furnace temperature must have been a disagreeable surprise to the early metallurgist, who found in his furnace a lump of this hard, brittle, useless material instead of the mass of malleable iron or steel which he hoped to produce. In the course of time, however, he would discover that this useless metal could have its pristine malleability restored to it, or, as he expressed it, the iron could be "freshened" by heating it in another (or possibly the same) furnace. Naturally, at that period the fact that the white iron was simply highly carburised, and that the freshening process consisted in burning out its carbon, could not have been suspected; but when this technical stage had been reached, the iron-worker no doubt soon learnt to appreciate the advantage of a continuous process in which the metal could be made to flow out from his reduction furnace, over a discontinuous process in which the lump of metal had to be dragged out of the furnace either by tearing down the furnace front or by lifting the lump bodily out of it. This step would lead to a still further increase in furnace and bellows capacity, and this in turn would bring about a further increase in furnace temperatures, with the again unexpected result of producing grey cast iron, as soon as the temperature became high enough to reduce some silicon.

### Early Manufacture of Castings.

It would soon be found that such iron ran very fluid, and was admirably adapted for making castings. Apparently one of the very earliest forms of iron castings was the iron stove plate, which originated in Germany. A sketch is known, from which a stove plate was evidently intended to be cast, dated 1474, in Nassau, though the plate itself has not been found. The oldest known cast-iron stove plate is dated 1497, and was from Eifel, which appears to have been one of the earliest centres at which castings of this kind were made. No doubt it took the early founders some time before they learnt to adapt their bronze-founding technique to this new material, very much in the same way as in our own time iron-founders have had to learn to modify their methods for the successful production of steel castings; but the superior qualities of articles made of cast iron would be a sufficient incentive to urge these early workers to find out how to overcome their difficulties. Once this was done, a demand for such pig-iron would arise and the blast furnace making charcoal iron was evolved.

The next step was the substitution of coke for charcoal, thus attaining the production of still higher temperatures; it is, by the way, interesting to note that the first coke furnaces still used bellows worked by a water-wheel, just as in Agricola's time, and that these continued in use up to the middle of the eighteenth century. About that date they were, however, replaced by

iron blowing cylinders, capable of generating a more powerful blast, and, therefore, of producing higher temperatures, whilst Neilson's invention of the hot-blast in the year 1828 enabled still higher temperatures to be attained in the blast furnace.

### Bessemer Converter and Siemens Open-Hearth Furnace.

The next stage was the production of mild steel in the Bessemer converter and the Siemens open-hearth furnace, to be followed by the important modification of Thomas and Gilchrist, which we know as the basic process. Necessarily, these processes involved the use of still higher temperatures than had hitherto been attained, and finally we reach the production of alloy steels in the electric furnace, with its capacity for generating still higher temperatures.

I do not wish to imply that each one of these successive stages immediately and definitely put an end to all use of the earlier processes. Quite the contrary is the case, for there are many examples of the old and new methods working side by side. Probably the first furnace in which cast iron was produced was the mediæval German *Stückofen*, and it seems that in this furnace either malleable iron or cast iron could be produced, though it is not clear that the mediæval smelter understood how to produce either the one or the other at will. Even to-day in India and in many other semi-civilised countries the direct process is still in use. Although cast iron was produced at least as far back as the fifteenth century, the Catalan direct process survived in the Pyrenees until, at any rate, the middle of the nineteenth century, and I have seen a direct process in operation in the Adirondacks, on Lake Champlain, in 1879.

Again, although Abraham Darby successfully made pig-iron with mineral fuel as far back as the year 1735, charcoal blast furnaces are still in operation in Sweden and various other parts of the world, and there was even one still at work in this country until quite recently at Backbarrow, near Ulverston; this little furnace used cold-blast as recently as the year 1909, when I, as consulting engineer to the company owning it, put in an iron pipe stove for heating the blast, and it was making charcoal iron until it was changed over to cold-blast coke pig-iron on December 17, 1925. In spite, however, of this overlapping of processes and of the survival of the older methods alongside the newer ones, the line of progress is quite unmistakably defined.

### Metallurgical Advance and Deterioration of Product.

One interesting fact emerges from this review—namely, that each successive metallurgical advance has been attended by a deterioration in quality of the product (except in cases when an entirely new material has resulted), though each has been accompanied by such an increase in quantity of output as to more than compensate for the inferior quality, by placing increasing quantities of iron at the service of mankind. It is only necessary to compare the blast furnace of 1750, which, according to the records of the time, was doing excellent work when it produced 24 tons per week, with the modern furnace, which smelts that quantity in about half an hour. On the other hand, it is undeniable that puddled iron is inferior to iron made by the direct process, that coke pig-iron is inferior to charcoal pig, and that hot-blast pig-iron is not as good as cold-blast pig. Again, whilst structural steel was in one sense an entirely new material, from another point of view it is not unfair to say that it is an inferior material to the older crucible steel. Nevertheless, it is also undeniable that the world is distinctly the richer for having at its command the huge quantities of iron and steel that were quite unthinkable even a century ago.

It will, I hope, be admitted that this rapid review of the history of iron manufacture is correct, at any rate, in its main features, and that my contention, that the power to produce high heats has throughout been the controlling factor, is well founded; I want to make it clear that I consider that the various stages of iron manufacture and of the generation of ever higher temperatures are not two independent concurrent parallel lines along which the development of human civilisation has travelled, but that they are distinctly related as cause and effect. This being true of the past, what can we say as to the future? Just as there is a lower heat limit below which iron capable of being usefully applied in the arts could not be produced, so there must be an upper limit, and I suggest that this limit is reached when our furnaces are capable of generating a temperature sufficient to volatilise the iron; it seems fairly obvious that heats higher than this cannot well be usefully employed. Such heats are, however, now readily attained in the electric furnace, and it would, therefore, seem that from this point of view the limiting condition has already been reached by the metallurgist. On the other hand, there seems but little inducement to increase the quantity of output, seeing that our potentialities of production appear to be now actually ahead of the world's requirements, and that there is every indication that even our present appliances will enable us to keep pace with any future demands.

### Future Progress to be along Different Lines.

It is not implied that we have reached finality in the metallurgy of iron, but that future progress will have to be along different lines. Fortunately, we are already able to see what direction this progress must take. Recent advances have all been in the direction of improvement in quality and in the attainment of properties in which ordinary iron by itself is deficient, such as we have already obtained by the use of alloy steels, of which Sir Robert Hadfield may well claim to be one of the pioneers. In other words, the future of the metallurgy of our metal will be directed, not by the crude methods of trial and error of the past, but by the application of principles developed by the methods of scientific research. For something like four centuries this country has led the way in the great improvements in the iron industry along the old lines which have been described; we are, however, also the inventors of the science of metallography, and alloy steel, with its numerous possibilities, of which high-speed tool steel may be quoted as an example; we may, therefore, fairly claim that even in modern scientific methods we are equally leading the world in the metallurgy of iron, and there is every reason to presume that the great work which the members of this Institute have done in the past in developing that iron industry which is the basis of our modern civilisation will still continue in the future, although, as has been suggested, that work will be carried on by means of modern methods and be based upon entirely different principles.

## Civil Engineering Awards.

The Council of the Institution of Civil Engineers have recently made the following awards in respect of Papers read and discussed at the ordinary meetings during the Session 1928-1929:—A Telford Gold Medal and a Telford Premium to Mr. Conrad Gribble, M.Inst.C.E. (London); a George Stephenson Gold Medal to Mr. Harry Hall, M.Inst.C.E. (London). Telford Premiums to Messrs. H. N. Colam, B.A., Assoc.M.Inst.C.E. (London); F. W. A. Handman, M.Inst.C.E. (London); T. P. M. Somers, M.Inst.C.E. (Glasgow); H. V. C. Johnstone, O.B.E., M.Inst.C.E. (Sudan); and jointly to J. H. Hyde, Assoc.M.Inst.C.E. (Twickenham), and H. R. Lintern, M.Sc., Assoc.M.Inst.C.E. (Teddington).

## Big U.S. Iron Ore and Steel Alliance.

An alliance between the £20,000,000 Cleveland-Cliffs Iron Company, the largest iron-ore concern in the United States, and the Eaton interests, which control the most important United States group of independent steel companies, was announced to-day (Tuesday) by Mr. C. S. Eaton, head of the Cleveland and New York banking house of Otis & Company.

The Eaton steel companies, which include the Republic Iron and Steel Company, the Youngstown Sheet and Tube Corporation, the Inland Steel Company, the Central Alloy Corporation, the Otis Steel Company and the Wheeling Steel Corporation, next to the United States Steel Corporation, are the largest users of iron ore in America, with an aggregate ingot capacity of 14,000,000 tons or 70 per cent. of the capacity of the United States Steel Corporation. The Cleveland-Cliffs Iron Company occupies a dominant position in the Lake Superior ore region, controlling numerous mines and extensive ore reserves and operating a fleet of ships on the Great Lakes.

Mr. Eaton, who is a Canadian by birth, is one of the most prominent figures in American finance. In addition to his banking and steel interests he is also identified with the United Light and Power Company, which is one of the largest public-utility undertakings in America. Recently he and his associates secured control of the Goodyear Tyre and Rubber Company, the largest rubber concern in the world. Mr. Eaton has always taken a great interest in the industrial and financial problems of the British Empire. He attracted considerable attention by a recent speech at Ottawa, in which he voiced the belief that Canada would eventually assume leadership in the development of the Empire's resources.

## Publication Received.

We have received the pamphlet containing the "Report of the Fourth Three Years' Working of the British Chemical Standards Movement," which was presented at the General Meeting at York on January 11, and it shows very decided progress during the period.

It may be remembered that this movement which is carried on entirely by the voluntary work of co-operators—now over 90—in this and other countries, has for its object the co-ordination of analytical work, and thus giving a *definite* known value to the results of all chemists who control their work by these standards.

Already these standards both ferrous and non-ferrous are being used by some 850 laboratories, of which nearly 170 are in other countries, in five continents, and comprise a very wide range of types of users, both public and private, including a large number of Universities and other educational establishments, whilst the quantity of material controlled runs into millions of tons.

Those interested should refer for details to the Report itself, which is pleasingly printed in clear type, easy to read.

A new and useful feature of this publication—rendered desirable by the international character of the work—is the inclusion of some explanatory remarks for those "who have not seen the earlier reports, and may therefore want to know something about the Movement generally," printed in French, Italian, Spanish, Polish and English. After reading this, even those who do not readily read English will more easily be able to follow the other matter, much of which consists of tables. There are also included brief epitomes of the three previous Three Year Reports. A contents page makes the whole easy of reference. Copies may be obtained from the Organisers, 3, Wilson Street, Middlesbrough.

# Monel Metal.*

By W. McCulloch.

(*Continued from page* 326.)

### Paddle Wheel for a Sugar Refinery.

This casting (Fig. 9) was run from the bottom. The blades, 20 in number, were all made from one core-box supplied by the customer, which, whilst closing, were all placed hard up to one another. Nineteen cores filled the mould, and there was still another to be inserted. The blades being all the same thickness, it was necessary to take them all out and file or card fully $\frac{3}{16}$ in. off each core. This is just one of the many things that foundrymen have to do about which the customer knows nothing. The thickness of the metal on the hub was about 2 in. The casting turned out extremely well, in spite of all the trouble expended in preparing the mould. The weight of the dressed casting was 6 cwts. 1 qr. 21 lbs., but the metal melted, including gates, runners and feeding risers, was 7½ cwts.

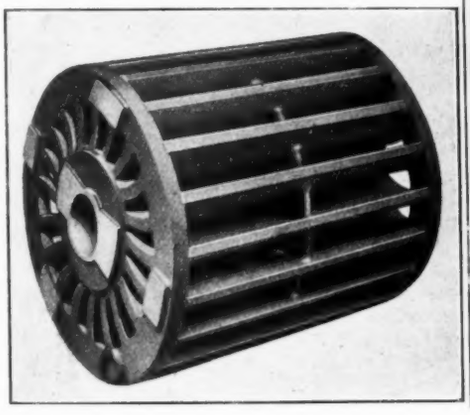


Fig. 9.—Cast Monel-Metal Paddle Wheel, Made for a Continental Sugar Refinery.

### Propeller for Steam Yacht.

The propeller shown in Fig. 10 was made for a luxurious yacht. It was made and cast similar to those cast in bronze—swept up from spindle and strickle, only it was run from the top of the boss. The owner, who was refitting his yacht and desiring something bright and enduring, stipulated Monel metal. The four bollards, when being cast, each took about 7 cwts. All the deck fittings were made of this metal, even the ship's bell, which had a beautiful tone.

Fig. 11 shows another bell, similar to the above. It was cast from the top, and, after being machined and polished, had a splendid appearance.

Fig. 12 illustrates a pickling raft, cast in high-silicon Monel metal. This high silicon increases the fluidity and the hardness of the metal. The casting was 8 ft. long and 3 ft. broad. It was cast with the plain side down. The drag was made in dry-sand. The casting was in the top part, and was made in green-sand for two reasons:—(1) The drag, being in dry-sand, eliminated all possible chance of scabbing or sand being washed in at the gate; and (2) taking into consideration the length of the casting (8 ft.) and the contraction (¼ in. to the foot), provision had to be made to let the casting creep in 2 in., a factor too important to allow of any risk of the casting being held in a dry-sand mould.

The casting was run from the side and at both ends, a gate being placed on every arm. Immediately after the casting was set, the operatives slackened around the risers and the gates, lifted off the top part, and loosened all the sand between the arms. The weight of the dressed casting was 7 cwts. 12 lbs., whilst the metal melted, including gates and risers, totalled 10 cwts. Six crucibles were used for this cast, and one test bar was taken out of each, with the results shown in Table 1.

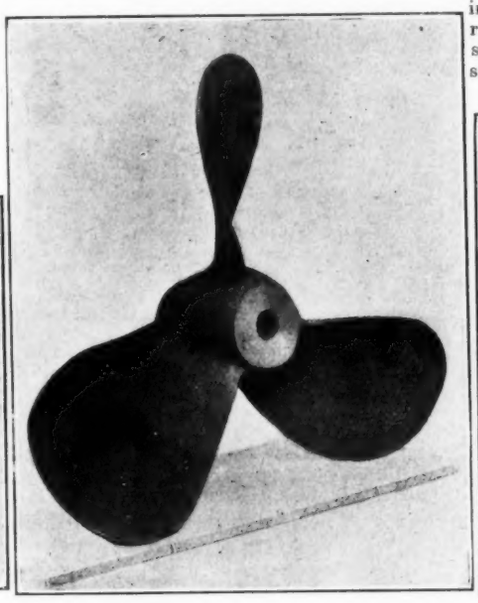


Fig. 10.—Propeller for Private Yacht.

Table I.—*Variation in Tensile Properties of High Silicon Monel Metal.*

| | Yield stress. | Maximum stress. | Elongation. |
|---|---|---|---|
| | Tons/sq. in. | Tons/sq. in. | % on 2 in. |
| No. 1 .. | 24.24 | 38.04 | 18 |
| „ 2 .. | 26.80 | 37.92 | 15 |
| „ 3 .. | 25.20 | 37.52 | 16 |
| „ 4 .. | 27.40 | 36.00 | 11 |
| „ 5 .. | 25.60 | 38.48 | 20 |
| „ 6 .. | 27.00 | 39.00 | 17 |

### High-Tensile Bronze.

One outstanding fact of brass founding as compared with iron founding is the great difference in the cost of the metal going into the moulds. A pound of good-quality cast iron costs ½d. per lb. in the ladle, as against non-ferrous alloys which may range from 4d. to 1s. 6d. per lb. A foundry waster in cast iron may not amount to much, whereas a similar waster in some of the non-ferrous metals involves a greater loss of profit.

Generally speaking, non-ferrous alloys call for greater care and accuracy at every stage. In a foundry, melting materials ranging from aluminium to Monel and pure nickel, constant care and supervision are required during moulding, melting and pouring, whereas with cast iron, once the cupola conditions have been established, charging and tapping proceed almost automatically, yet every crucible of non-ferrous alloy requires individual attention, especially with regard to the correct temperature for casting.

In ordinary Admiralty gunmetal, liner-metal, mercantile gunmetal, brazen metal, the author seldom, if ever, takes the temperature before casting. It is surprising how near one can approach to a defined temperature when doing it day after day, yet for special bronzes, aluminium alloys, it is the author's practice never to cast without first taking the temperature with the pyrometer. Neglecting the correct casting temperature is quite sufficient in itself to bring about a waster casting.

Different grades of manganese brass can be made, depending on the purposes for which they are required. Owing to their peculiarities, these alloys are rather difficult to handle in the foundry. The high liquid-contraction and shrinkage must be allowed for by means of risers and large feeding heads. This is one of the many alloys used for pumps and propellers, and in places where strength and resistance to corrosion are of paramount importance. An alloy similar to this has been specified and used successfully for locomotive axle-boxes.

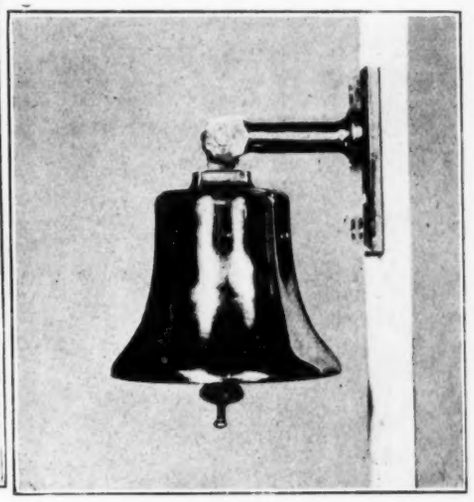


Fig. 11.—Ship's Bell in Monel Metal.

The method adopted for manufacturing this high-tensile bronze is to melt it in crucibles and cast into ingots, re-melting these again for pouring into the moulds. The usual procedure is to place the iron at the bottom of the crucible, which is generally supplied in pieces from ½ lb. to 1 lb. weight; ferro-manganese and copper next, adding the aluminium and zinc after the crucible has been taken out of the furnace.

A mixture of copper, special spelter, ferro-manganese, aluminium and iron, if properly manufactured, should give a test bar of the following mechanical properties:—Yield point, 24.80 tons per sq. in.; tensile strength, 40.64 ton per sq. in., and elongation, 21 per cent. on 2 in.

### Pump Casings Cast in High-Tensile Bronze.

If only one or two of these castings, weighing from 5 to 6 cwts. each, are urgently required, they are generally cast either from the tilting furnaces or pit fires; but the normal method is to utilise the air furnace, which is put into commission as soon as there are 3 to 7 tons of pump castings on order. Gates, heads, runners, etc., when being remelted, are always mixed with about one-third of new metal, as experience has shown that it ensures consistent results.

High-tensile bronze has a high surface-tension, due to the formation of an oxide film on the surface. Attention must therefore be paid to gating and running, otherwise laps may be formed, due to the two streams when meeting may not unite perfectly. The casting temperature employed is 1,000 deg. C.; below 960 deg. or above 1,020 deg. C. is undesirable.

* A Paper read before the Scottish Branch of the Institute of British Foundrymen, Mr. J. Longden presiding.

Fig. 13 shows a mould for a pump casing, with the core placed in position ready for the top part to be placed on. These are always made in dry sand, and run from the bottom flange, the gate being placed in such a position that the metal is flowing into the flange, the inlet being about 1 in. deep, 2 in. broad; and for a heavy casting, where the metal has further to run, the gate is made proportionally deeper. A heavy riser is put on the flange, and the main or centre part of the casting is "riser all around." Difficulty was experienced with some of these castings through leakage at the side flange. This was invariably in the bottom side or the side cast-down, the cause being, as was found, that the flange was at the opposite end from the pouring gate, and that the metal flowing in and through the mould, when it came into the flange, was at too low a temperature. Chills were tried all round the flange and on both sides, which helped, but did not cure. What was needed was a means of escape for the dull metal at the bottom

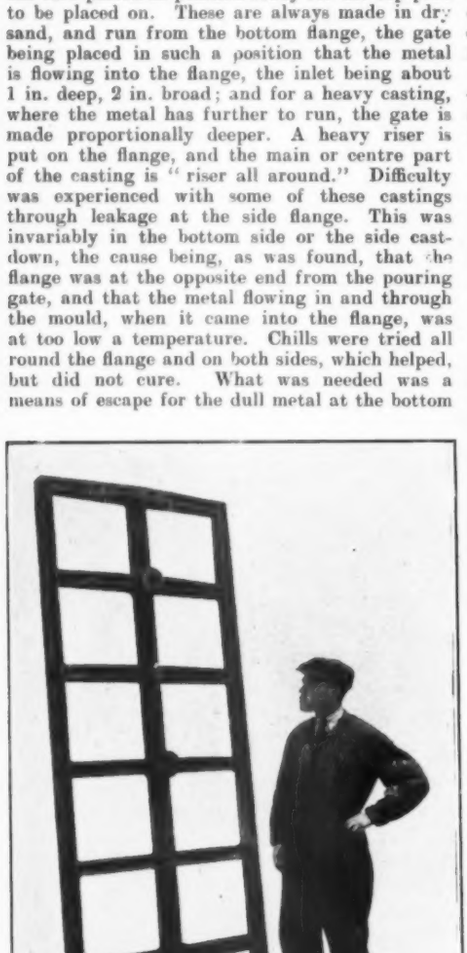


Fig. 12.—A Pickling Raft, cast in Monel Metal.

of the flange and its replacement by hot metal, therefore a false "flower" was cut at the bottom of the flange (see Fig. 15), which cured it completely. In making fresh patterns for these castings, the pattern-maker provides the necessary risers from instructions received from the foundry.

Before closing on the top, the head box is placed in position, and all heads and risers are then made up. A strainer-gate tin is used for the gate, which keeps the mould clean and provides a means for filling up the head. In moulding these pumps, the practice is to ram them up on a board, making a parting at the top of the flange. The drag is then placed on and rammed up. When parted off the gate is cut, the pattern drawn and the flange finished. The drag is then replaced, and the whole turned over. It is made in the same way as one would make a pulley-wheel in a two-part box, which eliminates the use of a middle part. Of course, the size of the casting is the determining factor.

Fig. 14 shows the core, which is made from as poor a sand as it is possible to use, so that when solidification takes place it will collapse. The sand as used for the cores is as follows:—Ordinary core sand (generally made from ground ashes and rock sand), 60 per cent.; ordinary floor sand, 30 per cent., and sharp sand, 10 per cent. This sand is so poor that if any of the cores become damaged, it is almost impossible to repair them.

The core-box is made in halves, but to facilitate closing a parting is made underneath the volute; so to be correct, the core is made in three parts, with a loam-core placed on the top to go through

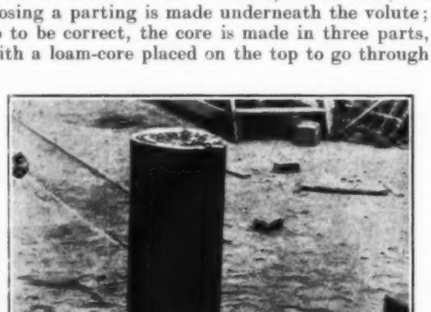


Fig. 13.—Mould for Pump Casing.

the riser. In Fig. 14 can be seen the spaces that are provided, through which the metal has free access to feed down to the bottom of the casting. This is done purposely—provision being made for it in the core-box. These are machined out into the volute in the engineering department. The space is never any more than from $\frac{1}{4}$ in. to $\frac{1}{2}$ in. in depth. The core iron is made from $\frac{1}{4}$ in. round iron.

**Closing.**

In closing the boxes, the bottom or drag core goes in first, then the volute is placed in position, care being taken that it is in its proper place, lying exactly level according to the shape of the mould; then the loam core is placed in position. After the top-part is finished, a 56 lb. weight (or more if necessary) is placed on top of the core to keep it in its proper place whilst pouring.

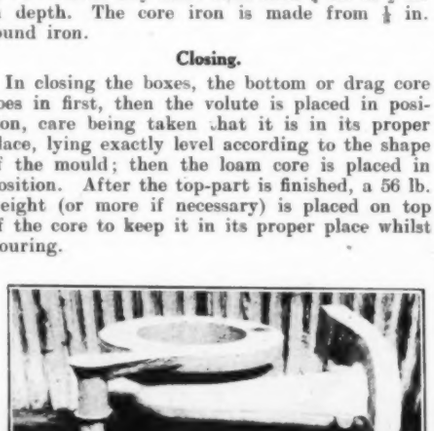


Fig. 15.—Pump Casing showing Method of Running.

When casting, as the ladle proceeds from box to box, an operator takes the temperature of every casting separately, and a record is kept of every casting made. When the boxes are emptied, but before the castings are removed to the dressing shop, they are typed with a serial number, so that if any casting is returned five or ten years hence, it is possible to ascertain date cast; mixture of metals used; temperature; job number; pattern number, and also the identity of the man who closed the mould.

Fig. 15 shows one of the castings, weighing 10 cwts. 2 qrs. 1 lb., including head. Note the false or French "flower."

In Fig. 16 is shown a large pump casing of a different style. Two castings were made off this

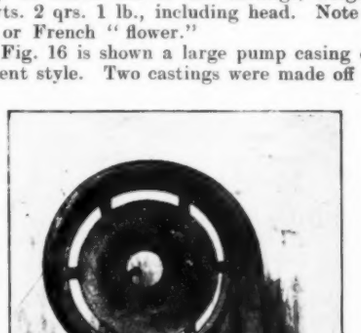


Fig. 14.—Core for Pump Casing.

pattern. They were made in practically the same manner as has been described. The heavy strengthening ribs around the volute, from the designer's point of view, were essential, but for the foundryman were a source of trouble and anxiety. However, all the difficulties were overcome with chills at the fillets and feeding risers on every rib.

The core also gave some difficulty owing to the design, but after consulting with the manager of the machine shop, a part of the core was cut off, this being later machined out in the engineering department.

During closing much care had to be exercised; the cores being made of the "poor" sand made it difficult during bolting down. Whilst making the cores, provision was allowed for this by leaving a 3-in. hole right through all the cores and the drag. A 1 in. bolt was passed through the whole; the complete box was lifted up by the crane, the bolt then placed in posi-

Fig. 16.—Pattern for Pump Casing.

tion, screwed down from the bottom, and placed on a bed and cast. Each casting weighed over two tons, including risers, but after the gate and runners were removed; the pouring temperatures of the two castings were 1,000 and 990 deg. C. They were tested to 2,250 lbs. per sq. in., the usual test such castings are subjected to, ranging from 700 lbs. to 2,250 lbs. for special castings.

These large pump casings were made to the order of the Commonwealth Edison Company, for the Crawford Avenue Power Station, Chicago, one of the biggest power stations in America. The largest one extant is in New York, and is called Hell's Gate.

Each pumping set consists of a steam-turbine-driven rotary-pump, delivering to the suction end of an electrically-driven multistage rotary pump, the capacity of each set being 500,000 lbs. per hour, or equal to 50,000 gallons per hour, against a discharge pressure of 540 lbs. per square inch. The horse power is 525, and the number of stages in the electrically-driven pump is 3. The shaft runs at 3,600 r.p.m., whilst the steam-driven pump is a single-stage type, and runs at 5,000 r.p.m.

It is something that British foundrymen should be proud of, that after many refusals in America they came to Britain to have these special castings made.

It is six years since the author started the system of keeping a record for this particular metal, and during those years he has cast 1,141 pumps in high-tensile bronze. During the last two years, from December, 1926, to December, 1928, 284 were cast. There have been ten bad castings and one spoilt in the machine shop.

### Gunmetal.

*The Melting of Gunmetals.*—It has been said that it is not the cost of labour or material, but the wasters which eat up the profit. That is quite true in one way, but, at the same time, it is necessary for the non-ferrous foundry to operate on economical lines, owing to the serious cost of upkeep furnaces, crucibles, and the price of metal melted therein.

In many brass foundries, the old-fashioned type of pit furnace is still in use. At Messrs. J. & G. Weir there are six in use every day. Though this type is far from ideal, it has many good points. The author remembers reading in a FOUNDRY TRADE JOURNAL an article upholding the pit furnace. This article maintained that when taking off from 100 to 200 lbs. of gunmetal it was as good as any of the tilting furnaces. With care one could get 60 to 80 heats out of an ordinary crucible, taking from 1½ to 2 hours for each melt.

It is no uncommon thing to find foundries taking 2½ hours to melt this weight of metal. One can expect a great amount of trouble from this cause alone—stewing the metal and melting under oxidising conditions. The golden rule in all brass foundries is to melt rapidly and avoid oxidation. It is not proposed to compare all the different types of furnaces and crucibles, but rather to outline the result of tests carried out at Cathcart in furnaces in use every day.

When large quantities of metal are required at one time, the air furnace is used. Two of these are available, each of 7 tons capacity. Under Mr. Affleck's supervision an air furnace test was carried out, the object of which was to determine the cost of working and the ratio of coal to metal melted. The results are set out in Table II.

Table III is a log of one day's cast from two tilting furnaces. This was made to obtain a comparison between these two furnaces as to output, cost of working, and the quality of metal produced.

### Tilting Furnace (Crucibles 450 lbs.).

The average life of crucibles from these tilting furnaces is 59. For instance, the last four months of 1928 showed the following averages:—September, 64; October, 64; November, 58, and December, 48.

A record of each crucible and furnace is kept by the furnaceman himself. This is checked by the storeman, who keeps a separate record.

No special crucibles are purchased, but special care and precautions are taken with those in service. New crucibles are stored in a stove, which is always at a temperature between 120 and 130 deg. F. The firm pays the furnacemen a monthly bonus for tear and wear of clothing, and a six monthly bonus on the number of heats received over a certain amount, with the result that the melters take an active interest in their job. The highest number of heats from one crucible that ever came under personal notice was 97, and in another nearby foundry the furnaceman reached as high as 108, when melting 400 lbs. in each heat of gun-metals requiring high temperature.

For the furnaces fabric one can use many varieties of firebrick, to some of which the clinker adheres like a limpet on a rock. When dislodged with the bar or poker, part of the brick is detached. The average life of lining, with adequate patching, is 370 heats.

TABLE II.—*Air-Furnace Test when melting* 88 : 10 : 2 *Gunmetal.*

| | |
|---|---|
| Weight of metal melted .. .. .. | 153 cwts. |
| Weight of coal used .. .. .. | 48½ cwts. |
| Ratio of coal to metal melted .. .. | 1 to 3.1. |
| Total time taken .. .. .. .. | 7½ hrs. |
| Metal temperature in ladles .. .. | 1,175 to 1,260 deg. C. |

TABLE III.—*Account of One Day's Cast from Two Types of Tilting Furnaces melting Gunmetal. (Six Heats from Each.)*

| | A. | B. |
|---|---|---|
| Time required to make furnaces ready for first charge | 30 mins. | 13 mins. |
| Average weight of coke used for each heat | 96.3 lbs. | 90 lbs. |
| Ratio of coke used to metal melted, including lighting up fuel | 1 of coke to 4.15 of metal. | 1 of coke to 4·44 of metal. |
| Average time required for each heat | 67.2 mins. | 59.5 mins. |
| Average water pressure of blast | 1.95 in. | 2.33 in. |
| Average temperature of metal in first ladle | 1,250 deg. C. | 1,260 deg. C. |
| Average temperature of metal in last ladle | 1,265 deg. C. | 1,292 deg. C. |
| Weight of new crucible before test | 70 lbs. | 70 lbs. |
| Weight of crucible after test .. | 71½ lbs. | 73 lbs. |
| Weight of metal for each charge | 400 lbs. | 400 lbs. |

The coke used throughout the tests contained 89.1 per cent. of fixed carbon.

TABLE IV.—*Tests on Pot Furnaces melting Admiralty Gunmetal.*

| Heat number .. .. | I | II | III | IV |
|---|---|---|---|---|
| Duration of heat (mins.).. | 80 | 50 | 60 | 45 |
| Quantity of metal melted (lbs.) | 224 | 224 | 224 | 224 |
| Consumption of coke (lbs.) | 86 | 56 | 47 | 44 |
| Weight of metal melted per lb. of coke (lbs.) | 2.6 | 4.0 | 4.75 | 5.1 |
| Temperature of metal in furnace (deg. C.) | 1,200 | 1,170 | 1,200 | 1,200 |
| Pouring temperature of metal (deg. C.) | 1,120 | 1,130 | 1,150 | 1,150 |

The coke used throughout the test contained 91.5 per cent. of fixed carbon.

Test-bars from each ladle all exceeded Admiralty requirements.

### The Question of Patching.

Nothing would be more foolish than to build or re-line a furnace and then use it every day without patching or repairing until it collapses. Repairing and patching when required saves both the fuel and the crucible. By using the ordinary brick as supplied by the furnace makers, one should get about 100 heats before any patching is necessary, but using a special brick supplied for the tilting furnaces—a little dearer than the ordinary firebrick—more than repays for any extra price paid. The furnace has lasted 500 heats before any patching was necessary, and, all told, with patching, 1,018 heats before relining was obtained.

In presenting this paper and the accompanying figures, it is not suggested that the methods used at Cathcart are the only ones, or even the best. However, an endeavour has been made to outline some of the methods and the results obtained there. In conclusion, the author would like to express his sincere thanks to the directors of Messrs. G. & J. Weir, Limited, and Monel-Weir, Limited, for their kind permission to publish this paper; to the management; and to Messrs. Arnott, Johnston & Bannister for their valuable assistance.

## International Foundry Congress, June, 1929.

Mr. K. W. Bridges, the hon. secretary of the Foundry Trades' Equipment and Supplies Association, Limited, announces the receipt of the following donations to the Central Hospitality Fund being organised in connection with the International Foundry Congress. This list is, of course, confined to members of the Association. Non-members should send their subscriptions direct to Mr. H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1:—

| | £ | s. | d. |
|---|---|---|---|
| Wm. Cumming & Co., Ltd. ... | 25 | 0 | 0 |
| FOUNDRY TRADE JOURNAL ... ... | 21 | 0 | 0 |
| Sterling Foundry Specialities, Ltd. ... ... ... ... | 10 | 10 | 0 |
| H. Winterton ... ... ... | 10 | 0 | 0 |
| The Constructional Engineering Co., Ltd. ... ... ... ... | 10 | 0 | 0 |
| The Coleman Foundry Equipment Co., Ltd. ... ... ... ... | 10 | 0 | 0 |
| Universal System of Machine Moulding & Machinery Co., Ltd. ... ... ... ... | 10 | 0 | 0 |
| T. Fearnley Allen & Son ... ... | 5 | 5 | 0 |
| Bradley & Foster, Ltd. ... ... | 5 | 5 | 0 |
| Blackfriars Foundry Requisite Co., Ltd. ... ... ... ... | 5 | 5 | 0 |
| Atlas Preservative Co., Ltd. ... | 5 | 5 | 0 |
| General Refractories Co., Ltd. ... | 5 | 5 | 0 |
| James Durrans & Sons, Ltd. ... | 5 | 5 | 0 |
| Spermolin, Ltd. ... ... ... | 5 | 5 | 0 |
| D. W. Lennox (Britannia Foundry Foundry Co., Ltd.) ... ... | 5 | 5 | 0 |
| Thos. Wilkinson & Co., Ltd. ... | 3 | 3 | 0 |

**Atomic Hydrogen Welding of Alloys.**—Apparatus used in atomic hydrogen welding consists of two tungsten electrodes and an electric arc established between them. Everything is shielded by a frame of hydrogen, according to a Paper by Mr. Peter P. Alexander, of the Thomson Research Laboratory, General Electric Company, before the Industrial Heating Conference, Massachusetts Institute of Technology. The torch used for welding consists of a support to hold the electrodes, and two tubes directing a hydrogen flame around them. All energy supplied to the weld is from an electric circuit. The gas serves only to shield the electrodes, to protect the metal from oxidation and to increase the efficiency of the arc. If an arc of the same current and length be maintained in an atmosphere of hydrogen, the potential drop along the arc core will be 15 times as great as in nitrogen. Hence, by blowing hydrogen toward this arc, the efficiency is increased. In this way it became possible to use the indirect arc in a very efficient way.

## Conditions in the Refractory Goods Industry.

The tenth annual social reunion given by Messrs. John G. Stein & Company, Limited, Castlecary, to their employees and friends in Bonnybridge Public Hall was attended by about 600. Colonel Alan Stein, M.C., presided, and was supported by Mr. Norman and Mrs. Stein. The Chairman, in welcoming the guests, said that during the past year the works had been fully employed and the output larger than the previous year, whilst their wages bill showed a considerable increase due to the larger number of hands employed. They had good reason to congratulate themselves on that fact. The country certainly wanted more houses for many years to come, and the high cost was the only obstacle to their erection. The cost of building-bricks worked out at 12s. per ton at the works, and it would be very difficult to find any other manufactured article that was made so cheaply. The firebrick part of the business was of course the most important, and there they were still fully employed. Many countries that formerly imported firebricks had started making them themselves—Japan, China, India, New Zealand, Italy, Australia and Spain. It meant that if they were to retain their export trade they could only do it by producing better firebricks than these countries could do themselves at the lowest possible price. The home trade competition in regard to quality and price was keener than ever, but so far they had managed to keep their end up pretty well, especially when they considered that the firebrick trade generally had not been busy. He was sure that they would continue to do all they could to keep abreast of the times, and with their co-operation and good team work the quality of the products of the firm would go on improving and at the same time reduce the cost of production, thus securing a continuance of the trade they had. Colonel Stein mentioned that they originally estimated that the new works at Manuel which were commenced last year would get into production in about a year's time. He also made reference to his recent visit to America and said that he was impressed by the readiness with which they scrapped old plant if costs could be reduced by so doing, and also the real progress that was being made in that country. In this country there was still a feeling that to increase output per head was to throw someone out of a job. That feeling did not exist in America. He was very keen to encourage piece-work, and it might interest them to know that he had worked out the average earnings of those they had on piece-work, taking a fortnight's pay at random. He found that they were drawing 27 per cent. more than if they had been on time rate. That was a substantial benefit to the piece-workers, and they got it without increasing costs, in fact it reduced costs. Apart from the benefit to the individual, the higher wages meant a bigger spending power or, what was better, a bigger saving power. He believed that they in this country could only maintain the higher standard over Continental nations by earning that higher standard, by producing better goods and increasing the production per head.

Colonel Stein reminded the audience that any suggestions from the workers for the reduction of costs, improvement of quality, or the conditions of work, would be very welcome and would receive very careful attention from the directors. Any suggestions adopted would be paid for. He concluded by announcing that he had been considering the best method of forming a works committee with representatives from the different departments who could deal with questions of welfare, conditions of work, and grievances.

## Catalogues Received.

### Aluminium Bronze.

We have received from The British Aluminium Company, Limited, of Adelaide House, King William Street, London, E.C.4, a copy of the Booklet No. 315 bearing the caption and dealing with Aluminium Bronze in all its phases. We have only one exception to take in connection with this publication, and that is that apparently it is to be supplied free of charge to any interested person applying for it. A book of this character is well worth paying for, and we can assure our readers that they could easily pay 15s. for certain technical books and not obtain one iota of true value—that is, the disclosure of information of an exclusive character—as can be associated with this 76-page well-illustrated booklet. The book is divided into 8 sections, the first of which is of an introductory character and reviews the subject from the viewpoints of the designer, the founder and the user. Section II is devoted to Foundry Technique, and as the author's identity is thinly veiled above the initials "G. M.," there is an assurance that a vast store of practical experience, which gives the cachet of reliability to any advice tendered. In Section III the author wisely stresses the tendency to auto-annealing and sets out boldly the steps to be taken for its prevention. Having done this, the influence of iron, nickel, manganese, lead and other elements on aluminium bronze are expounded. Section IV, though attenuated, is extremely interesting, as it shows how by heat treatment properties comparable with steel can be obtained. Quite a long section (No. V) is devoted to the die-casting of aluminium bronze, and it is perhaps in this field where, so far as Great Britain is concerned, the most progress has been made. In perusing Section VI (wrought alloys) we admit to the receipt of a slight shock when on page 53 we saw illustrated a 6-ton ingot of aluminium bronze being turned up in a lathe. For the compilation of Section VII the author has collected a series of very useful tables. Here we have just one suggestion to make, and that is, we hate to have to do bits of arithmetic in order to appreciate the import of a property of an alloy. Like most Britishers, we cannot readily appraise just what is meant by 82,000 lbs. per sq. in., and we suggest that in future editions of this book unification of methods of expressing properties should be adopted. Section VIII is for some curious reason called Appendices, of which there are three. No. 1 outlines the existing specifications for aluminium bronze; No. 2 reproduces a section of Al-Cu equilibrium diagram, and No. 3 a bibliography of 145 references. We strongly advise our readers to obtain a copy of this booklet, as being of real practical use to them if ever called upon to make this interesting alloy.

### Moulding Boxes.

We have received from Messrs. J. W. Sadler & Company, Limited, Bartle Lane, Great Horton, Bradford, a four-page leaflet (No. 101), which illustrates and describes the Du-Ram patent steel moulding box. The outstanding features of these boxes and snap flasks are rigidity, a sand gripping device, a double lug construction (enabling a long parallel lift to be obtained), and interchangeability. We think that a little more stress could have been placed by the issuing firm on their willingness to co-operate with the founders on meeting their special requirements in boxes, whilst still retaining the essential features of the standard design. A factor, not disclosed, but one in which most founders are interested, is the position of the weld. As such strong claims are made for strength, we can anticipate that a position under the lug has been chosen.

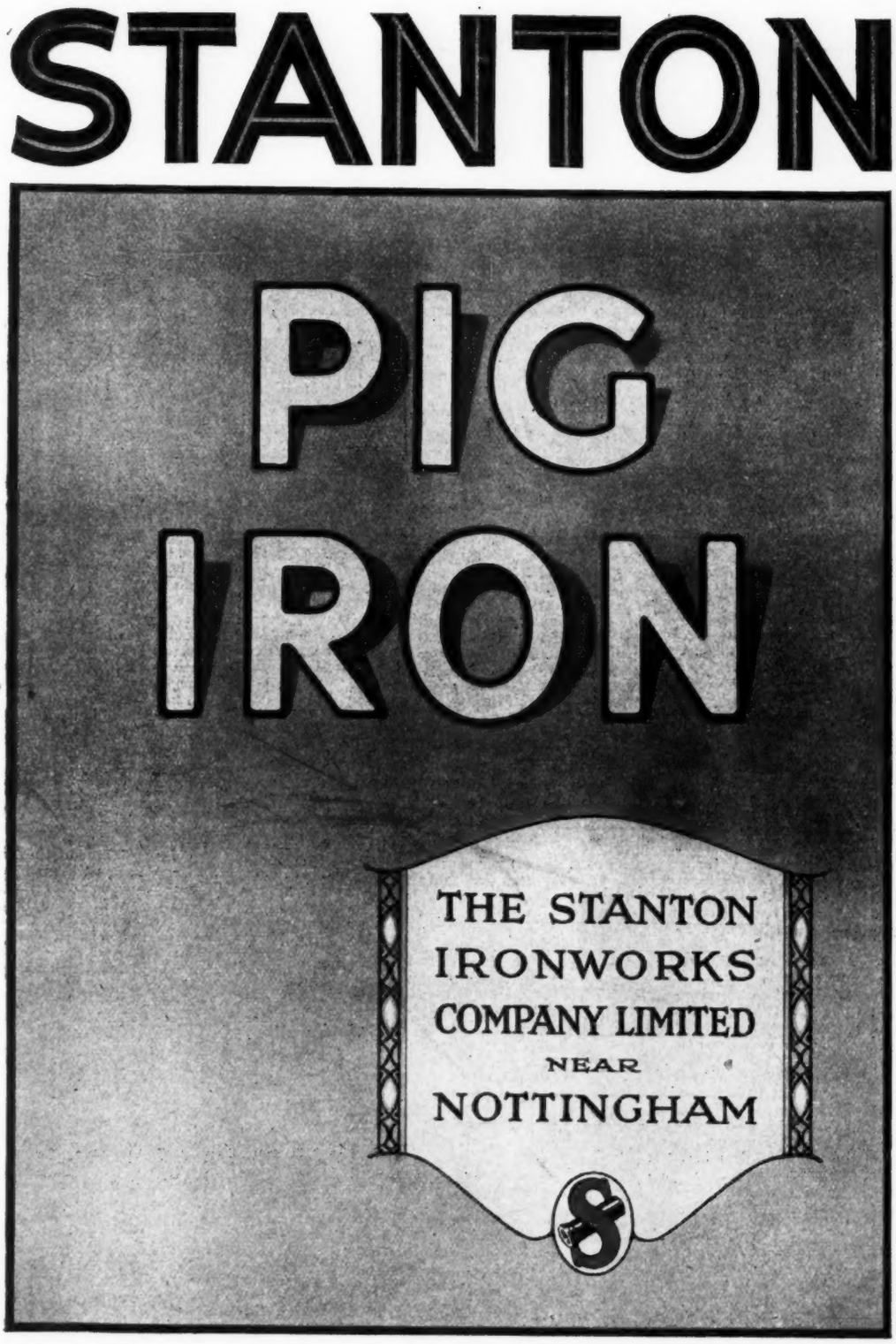
## Book Review.

**Matthew Murray — Pioneer Engineer.** Edited by E. Kilburn Scott. Published by Edwin Jowett, Limited, Park Street, Leeds. Price 2s. 6d.

We suppose that the engineering profession will insist that Matthew Murray was one of their most brilliant pioneers, yet a perusal of this most interesting book shows that the main mental occupation of his contemporaries and not too scrupulous rivals (Boulton, Watt & Company) was the provision of sound castings. Appendix A, which is a collection of letters from Matthew Murray to Simon Goodrich, engineer and mechanist to the Navy Board, shows up Murray as an enlightened engineer, whereas Appendix B—a collection of letters written by James Watt, Junior, and Matthew Robinson Boulton about Murray's activities—shows that they regarded him as an expert foundry owner. Abraham Storey, the foundry manager at the Soho works, was having a fairly "thin" time in the early days of 1799. In January he apparently became convinced of the inferiority of his output, and started experimenting with his sands, actually taking a boat load of the type used by Murray. In February poor Storey is reported to have effected no improvement, and was full of excuses. Three years later (1802) we find Watt, Junior, whilst spying on Murray's Round Foundry at Leeds, reporting on the foundry practice there. In a letter to Boulton he states ". . . confirms Dixon's report that the nozzles are all made in dry sand. The moulder is dead who made them in green sand, and they have no workman now who can do them. Says he does not think much of their moulders, although he is sensible of the great perfection of their green sand work, which he attributes entirely to the sand. Says it is exactly the same as we had at the (Soho) foundry, but that we spoiled it by mixing too much coal dust with it. . . . Connecting rods, shafts and wheels of every description are made solely in green sand, but no pipes or hollow goods. . . . They melt a great deal from the cupola, which is about 8 feet high and 20 inches diameter, and in which they do not use one-third of the coaks which we do to the same quantity of iron . . ." says the iron runs much finer from the cupola than ours does, and about 6 cwt. per hour. The worst burnt stuff they can get comes out excellent. Cylinder bottoms, tops and pistons are all made in green sand, until they come to be very large. They had a terrible blow up a short time ago in making a large cylinder." Thus in letter after letter does foundry practice figure, and bears out our contention that Murray can be considered as an exceedingly prominent iron and pioneer foundry owner. It is rather striking that whilst the names of most of the prominent engineers and foundry men of that time are repeatedly mentioned, Wilkinson, who is worthy of being classed with the best of these pioneers, is scarcely mentioned. We never remember reading a book which gives a better insight into the mental make-up of the early British industrialists, and one can easily visualise the effect produced on their successors, and even on modern industrial conditions, in its best and worst aspects. The book has an appeal for a wide circle, and no matter what the interest of a modern foundryman may be, it is probable that he will find matter either of an enlightening or interesting character. The revenue from the sale of the book is to be devoted to a Murray Centenary Memorial Fund.

## B.C.I.R.A. New Members.

The following firms have recently joined the British Cast Iron Research Association:—Herbert Morris, Limited, Loughborough; Ealing Park Foundry, Limited, London; Vickers, Limited, Crayford, and Mitchell, Russell and Company, Limited, Bonnybridge.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THE STANTON
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## Trade Talk.

Sir James A. Cooper has been appointed a director of Messrs. Vickers-Armstrongs, Limited.

Mr. John Walker, 37, Westbury Street, Wolverhampton, malleable iron founder, has been adjudicated bankrupt.

Messrs. Bolckow, Vaughan & Company, Limited, are blowing in two additional furnaces at their South Bank works.

The employees of the Carntyne Steel Castings Company, Limited, Renfrew, have contributed £60 to local charitable institutions.

The Flexible Drive & Tool Company have removed from 35, Bloomsbury Square, to 3, Bloomsbury Place, Bloomsbury Square, London, W.C.1.

Messrs. Darwins, Limited, Sheffield, have received a large order for magnet steel from a Dutch firm of electric lamp and radio apparatus makers.

Messrs. Verdon, Cutts & Company, Limited, Sheffield, have received a further order from the South African Government for an electric furnace.

Trading in copper futures is expected to begin on the New York National Metal Exchange this month. So far the Exchange has dealt only in tin.

It is reported from Genoa that the Banca Commerciale Italiana has purchased from the Credito Italiano its share interest in the Ilva Iron and Steel Company.

The Millom and Askam Hematite Iron Company, Limited, announce that iron-ore shipments at Almeria from their Alquife Mines for the month of April totalled 36,900 tons.

Messrs. Dorman, Long & Company, Limited, are negotiating with the Redmire Limestone Quarry Company, Limited, for the acquisition of their limestone quarries at Redmire, Yorks.

Messrs. Alexander Slater, Lossiemouth, have launched a motor-boat for Messrs. James Flett, James Scott and James Mitchell. The vessel will be fitted with semi-Diesel engines.

The Dramatic Society run in connection with Messrs. Leys at Derby has contributed to local charities the sum of over £300 to maintain "Ley's Cot" at the Derbyshire Royal Infirmary.

The single-screw cargo steamer "Maya," built by Messrs. Barclay, Curle & Company, Limited, for the Cuyamel Fruit Company, New Orleans, has completed very successful trials on the Clyde.

Messrs. Pegler Bros., Limited, brassfounders, of Belmont Works, Balby, near Doncaster, having just completed a successful business year, have decided to grant all their employees a week's holiday with pay.

At a recent meeting of the Newark Engineering Society the prize-winning essay was gained by Mr. H. Stuffins, who read a Paper on "Mass Production," and Mr. L. S. Shaw was awarded the second prize for an essay on "Points for Oil Engine Users."

**A Russian Press agency announces that the Kertch Works has started its first blast furnace, which is stated to have a capacity of 250 tons of pig-iron per day. A second furnace, with a daily capacity of 275 tons, is said to be nearing completion, and the construction of a third has been started.**

Sir Alfred Ewing has been elected an honorary member of the Institution of Civil Engineers, "in recognition of his eminence as an investigator in the field of mechanical science, his distinguished services to engineering education, and the valuable scientific assistance rendered by him to the nation during the war."

Fire broke out in the works of the London and Forth Shipbuilding Company, Limited, Govan, last week and caused considerable damage. Workmen had been engaged loosening bolts on a steel beam in the main shop with an acetylene blowlamp, and it is thought that the surrounding material had become sufficiently heated to ignite the woodwork.

Messrs. Ferguson Brothers (Port Glasgow), Limited, have received from the Alexandria Towing Company, Limited, Liverpool, an order for a powerful passenger tender. The vessel will have twin-screw engines, obtaining steam from two boilers working under Howden's forced-draft system. Engines and machinery will be supplied by the builders.

A deadlock has been reached between the Boilermakers' Society and the Shipbuilding Employers' Federation regarding the negotiations for the adjustment of a claim made on behalf of the Clyde framers who are members of the Society. The men asked for payment for the punching of air holes in side-frames, but their claim has been rejected by a Central Conference. This exhausts the machinery for the adjustment of disputes.

A new company has been registered, under the title of "Parker Foundry (1929), Limited, Derby," to take over the old-established business of the Parker Foundry Company, Limited, the well-known manufacturers of steel and malleable-iron castings. The managing director is Mr. T. McLean, who has been associated with the steel foundry trade for over 40 years, and is well known in engineering circles.

At the annual meeting of the Derby Society of Engineers Sir Henry Fowler was re-elected President and Mr. Carmichael as chairman, and a vote of thanks was accorded Dr. Anderson, the retiring chairman. Mr. J. M. Roberts was elected hon. secretary and treasurer, and the following committee was appointed:—Messrs. W. Price-Abell, G. H. Haslam, two well-known ironfounders; R. Martin, S. Moore, B. L. Rathmell, P. Simpson and W. H. Swift.

The Tata Iron & Steel Company, India, is offering foundry pig-iron in Continental markets. The European selling company is known as the Tata Foundry Iron Export Company, Limited, and has established six offices in Europe with the intention of offering from 125,000 to 175,000 tons of foundry iron annually to consumers in Germany, Italy, and other countries. Exports of Tata pig-iron from India have steadily increased from 287,600 tons in 1925 to 383,960 tons in 1927 and about 428,000 tons in 1928.

The English Steel Corporation, Limited, of River Don Works, Sheffield, has taken over the commercial manufacturing businesses hitherto carried on by Vickers-Armstrongs, Limited, and Cammell Laird & Company, Limited, at River Don Works, Openshaw Works, Elswick Works (drop stampings and forgings), Cyclops Works, Grimesthorpe Works and Penistone Works. All liabilities relating to the above-mentioned businesses admitted by Vickers-Armstrongs, Limited, or Cammell Laird & Company, Limited, will be met by them.

A portion of the Clydebridge steelworks of Messrs. David Colville & Sons, Limited, known as the Old Side, will shortly make a resumption for the first time since the war. Instructions have been issued for the reconditioning of two of the nine acid furnaces, and it is anticipated that the repairs will be completed during June, ready to go into full operation immediately after the Fair holidays. It is estimated that about £15,000 will be required to repair the furnaces, and that three or four hundred extra men will be employed.

**The Arbed Company (Aciéries Réunies de Burbach-Eich-Dudelange) report for the financial year ended December 31, 1928, profits amounting to 196,718,266 fcs. (as compared with 153,738,390 fcs. in 1927). A sum of 90 million fcs. (65 million fcs.) is to be set apart towards the sinking fund, and 15 million fcs. (12.5 million fcs.) is to be spent on various social welfare works. A sum of 91,718,266 fcs. (76,238,390 fcs.) remains available for distribution; the dividend will be at the rate of 300 fcs. (250 fcs.) per share. The Société Schneider and Cie are the principal shareholders in the company.**

Vickers-Armstrongs, Limited, of Vickers House, Broadway, Westminster, London, S.W.1, have disposed of their commercial manufacturing business carried on at Sheffield and Openshaw Works, and the drop forgings and stampings business at Elswick Works, Newcastle-on-Tyne, to the English Steel Corporation, Limited, as at January 1, 1929. In future the above businesses will be conducted by that company, who will assume all liabilities in respect thereto. The armament side of the business carried on at the above works, consisting of gun manufacture, tanks and armoured cars, and the work at Elswick other than drop stampings and forgings, are in no way affected; nor are the other products of the company carried on at the Barrow, Erith and Dartford Works.

The Electric Furnace Company, Limited, have recently received a number of orders for furnaces in foreign countries, in some cases in spite of heavy import duties. These include two Héroult furnaces for India and Brazil, four Ajax-Wyatt furnaces, each of 600 lbs. capacity, and four Ajax-Northrup high-frequency furnaces, varying from 15 to 2 cwts. capacity, for France. They will also shortly be putting into operation a 1-ton Ajax-Northrup furnace in France. This furnace, of which the output is equivalent to a 4-ton arc furnace or an 8-ton open-hearth furnace, is the largest high-frequency furnace yet constructed, and has been designed and built in Great Britain. They will also shortly be starting three 5-cwt. Ajax-Northrup furnaces in France, which were ordered last year.

Interesting developments are taking place at Glenboig, where a new plant installed by the Bussey Coal Distillation Company, Limited, is nearing completion. The plant, which will deal with 6,000 tons of coal per 24-hour day, will, it is expected, be ready to commence operations in the early summer. Fourteen retorts are being erected, each 102 ft. high. Each retort has a capacity of 50 tons daily, and will produce gas, smokeless fuel and crude oil for Diesel marine engines, etc. The surplus gas will be absorbed in the production of power, and may also be used in the burning of firebricks. The plant is the only one of its kind belonging to the Bussey Company in Europe, and is similar to their works in the United States. At the moment some 200 men are employed in constructional work under the supervision of Dr. Haslam.

## Personal.

Mr. Edgar T. Gardiner, of Messrs. Lingford, Gardiner & Company, Limited, locomotive engineers and founders, Bishop Auckland, died on April 30.

Mr. Walter G. Gray, general manager of the Steel Company of Scotland, Limited, Glasgow, has been appointed a Justice of the Peace for the County of Dumbartonshire.

Samuel Warley, aged 54, a foundryman, employed at the Stanton Ironworks, has been admitted to the Nottingham General Hospital suffering from injuries to the back caused by falling down at his work.

Mr. William Darby, of Messrs. Darby & Company, iron and steel merchants, Birmingham, died recently, aged 70. Mr. Darby had been chairman of the Birmingham Board of Guardians.

Mr. James Pirie, of the firm of Messrs. Pirie & Sons, who is the oldest consulting and inspecting engineer in Aberdeen, has just retired from business, and to mark the occasion the consulting and superintending engineers, underwriters, surveyors and managers of repairing shops in the port entertained him and Mrs. Pirie to dinner in the Imperial Hotel recently. Mr. Pirie was presented with a wireless set and Mrs. Pirie with a gold wristlet watch

### Will.

Williams, I., J.P., of Wilderton, Branksome Park, Bournemouth, late of Normanby Hall, Normanby, Yorks, for some years chairman of the Dinsdale Iron Company, and a director of Bolckow, Vaughan & Company, Limited ... ... ... ... ... £235,353

## Obituary.

Dr. James Moir, of the Transvaal Mines Department, who has just died, was born in Banff in 1874, and was a graduate of Aberdeen University. He went to South Africa in 1902, where, prior to joining the Mines Department, he taught in Jeppe High School, was chemist to Messrs. H. Eckstein & Company, and started the original Rand Mines Laboratory. He was twice President of the South African Chemical Institute, and was also President of the Chemical, Metallurgical and Mining Society and of Section "B" of the South African Association for the Advancement of Science, from which he received the South African Medal. Dr. Moir was an assiduous research worker in organic and metallurgical chemistry, and was due to retire at the end of this year.

The death has occurred, in London, of Mr. William Miller, who for many years was prominently identified with the industrial development of Grangemouth and its dockyard. Mr. Miller was in his eightieth year, a native of Greenock, and a self-made man. After working in South America for a few years he returned to this country, and held appointments in various Clyde shipyards before becoming manager with Messrs. Russell & Company (now Lithgows, Limited), Greenock. In 1884 Mr. Miller took over the shipbuilding business of Messrs. Dobson & Charles, Grangemouth. A few years later he formed the Greenock yard, the company becoming the Greenock and Grangemouth Dockyard Company, and remained thus for 30 years until, at the termination of the war, the Greenock yard was taken over by the Clan Line, and the company became the Grangemouth Dockyard Company. The first fruit-trade vessels to be built—for the purpose of carrying fruit from the West Indies to the American coast—were built in the Grangemouth Dockyard.

XUM

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# IT IS TRUE THAT

as Professor Boswell says in his "British Resources of Refractory Sands"—

"The United Kingdom can be entirely independent of Foreign Supplies" and that
"Much of the Transport of Sands about the country for metallurgical purposes is unnecessary."

The first remark is justified in the light of results obtained by Steel Founders using

# YORKSHIRE SAND

and the second remark aptly describes our policy of maintaining Sand supplies in many districts—as near to our customers' works as possible, so as to avoid heavy freight charges.

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# Iron and Steel Markets.

## Pig-Iron.

**MIDDLESBROUGH.**—As noted in previous reports, the main difficulty of the Cleveland ironmasters at the moment is the urgent necessity for increased outputs of pig, both for steelmaking and foundry purposes, for which demand is steadily expanding in the home and export markets. The position at present, with stocks completely exhausted and production still restricted, has accelerated buying interest, consumers becoming anxious with regard to future price inflation consequent upon a scarcity of supplies. There is, moreover, no doubt that under present conditions higher prices could be obtained, and in some quarters an advance is thought to be not improbable. The area of distribution is also extending. It is several years since deliveries of pig-iron to Scotland were so heavy, while the foreign shipments from the Tees have not been equalled since March, 1926. No maker will now quote for prompt iron, but for the second half of the year quotations keep steady at the following levels:—No. 1 Cleveland foundry iron, 71s. per ton; No. 3 G.M.B., 68s. 6d.; No. 4 foundry, 67s. 6d.; No. 4 forge, 67s. per ton.

Although there has been a substantial increase in the make of East-Coast hematite of late, the market continues steady, and with the additional furnaces now in operation the output is now overtaking the demand, while it is now possible to buy with the promise of fairly early delivery. Prices vary. There are no fixed quotations, and makers are prepared to negotiate according to the size of the order. However, the general average figure is still put at about 74s. per ton for mixed numbers and 74s. 6d. for No. 1 quality. On the North-West Coast prices are firmly maintained, Bessemer mixed numbers being quoted at 74s. per ton at works, with low-phosphorus iron at 2s. 6d. to 5s. per ton above that figure.

**LANCASHIRE.**—Markets for foundry pig in this area remain quite uneventful, buying being again on a restricted scale, but with prices firmly maintained at recent revised rates. Current quotations rule as follow:—Derbyshire No. 3, 71s.; and Staffordshire brands, 73s. 6d. per ton, delivered Manchester and equal.

**THE MIDLANDS.**—In the Black Country districts, generally speaking, the ironfounders are somewhat busier, and when present contracts for foundry iron are exhausted, which is expected within the next few weeks, there may be a considerable amount of forward booking. There has been no further revision of prices, which remain as follow:—Derbyshire No. 3, 72s. 6d.; Staffordshire, 73s. 6d.; and Northants, 69s., delivered locally.

**SCOTLAND.**—As far as foundry pig-iron is concerned, April has been the quietest month for a considerable period, and there is no sign of any improvement. On the other hand, there has been a better demand for steel-making irons, especially basic. Prices for foundry pig-iron are unchanged on the basis of 72s. 6d. per ton for No. 3, f.o.t. furnaces.

## Finished Iron.

Conditions in the manufacturing departments of the industry continue far from satisfactory, but quotations are firm and makers are not granting any concessions, as they still have to pay high prices for scrap and forge pig-iron. Staffordshire marked bars are still £12 at makers' works, and crown iron is at between £9 10s. and £10 per ton, delivered in the Midland district. There is very little business being placed with the local ironworks for nut and bolt iron, as their price is nearly £2 higher than the figures quoted by the Belgian works for this material. The demand for crown and marked bars keeps up to a better standard, but, even so, there is not sufficient business developing to keep the works fully occupied.

## Steel.

At Sheffield a fairly brisk business is reported in the steel market, with basic billets still the chief feature at increasing prices. Acid billet demands are restricted. Imports of foreign steel are smaller, the prices being very little under those of British. Owing to the poor demand, a number of acid steel furnaces in this district have gone out of operation. Quotations:—Basic billets, soft, £7; hard, £7 12s. 6d. to £8 12s. 6d.; Siemens acid, £8 15s. to £9. Wire rods: Soft, £7 12s. 6d.; hard, £10 10s.; acid, £12. Steel hoops are at £9 10s. to £9 15s. The demand for finished steel is steady, and most of the British works are well situated for orders for some time to come. In the tinplate market conditions generally are easy, with quotations ranging as follow:—Coke tinplates, 18s. 3d. to 18s. 9d. basis, net cash, f.o.t. Welsh ports.

## Scrap.

With increasing activity in the pig-iron industry, a corresponding expansion of demand for foundry scrap material is now in evidence, and on the North-East Coast heavy cast iron is remarkably steady, with ordinary quality at 62s. 6d. and good machinery scrap in handy pieces at 66s. per ton. In Scotland supplies are not yet too plentiful, and consumers are accepting all that is offered at current prices. The market for cast-iron scrap is also a little easier, and it is difficult to dispose of first-class machinery at around 73s. 6d. Heavy ordinary cast-iron scrap suitable for foundries is at 67s. 6d., with list cast-iron scrap at 66s. 3d. to 67s. 6d., and firebars at 63s. 6d. Old cast-iron railway chairs are quoted at 67s. 6d. to 68s. 6d. The above prices are all per ton delivered f.o.t. consumers' works. At Sheffield the market for cast-iron scrap is less active, though prices are unchanged at 62s. 6d. per ton for ordinary and 66s. for machinery quality, both per ton delivered.

## Metals.

**Copper.**—Fluctuations of values in the market for warrant copper present no features of sensational interest, the tendency on the whole indicating a steady flow of business during the current week on the part of consumers at home and abroad. With regard to the future, the outlook is very difficult to estimate with accuracy, but everything seems to depend on whether producers can hold out until consumers are forced to buy again, and buy at the existing levels.

Closing quotations are :—

*Cash.*—Thursday, £78 10s. to £78 15s.; Friday, £79 to £79 2s. 6d.; Monday, £79 17s. 6d. to £80; Tuesday, £79 2s. 6d. to £79 7s. 6d.; Wednesday, £78 to £78 5s.

*Three Months.*—Thursday, £75 5s. to £75 10s.; Friday, £75 to £75 2s. 6d.; Monday, £76 5s. to £76 7s. 6d.; Tuesday, £75 15s. to £76; Wednesday, £75 7s. 6d. to £75 10s.

**Tin.**—Dependent, to a certain extent, on the movements of the powerful group now controlling market operations in standard tin, more confidence is apparent in the possibility of stable conditions being restored at an early date. Thus, although occasionally declining below the £200 level per ton, the view is held in influential quarters that the position is more hopeful, and, with consumption still maintained at a fair average, impending developments by outside interests may probably influence an early recovery in market values.

Official closing prices :—

*Cash.*—Thursday, £196 5s. to £196 7s. 6d.; Friday, £197 to £197 5s.; Monday, £197 10s. to £197 12s. 6d.; Tuesday, £197 15s. to £197 17s. 6d.; Wednesday, £200 17s. 6d. to £201.

*Three Months.*—Thursday, £199 to £199 5s.; Friday, £199 10s. to £199 12s. 6d.; Monday, £199 12s. 6d. to £199 17s. 6d.; Tuesday, £200 2s. 6d. to £200 7s. 6d.; Wednesday, £202 5s. to £202 10s.

**Spelter.**—Consumption of this metal is well maintained, and the demand from consumers, particularly on the Continent, remains steady. Early in the past week values fell as a result of fears expressed with regard to the renewal of the agreement among producrs, but, with the news of the decision of the Cartel, values showed an immediate recovery.

Daily quotations are :—

*Ordinary.*—Thursday, £26 12s. 6d.; Friday, £26 11s. 3d.; Monday, £26 8s. 9d.; Tuesday, £26 7s. 6d.; Wednesday, £26 12s. 6d.

**Lead.**—The market for foreign pig is at last showing signs of recovering from the effect of the recent liquidation in the copper market, and although there has been no marked improvement, the tone is steady. An improvement in the future, however, is anticipated, as it is understood that consumers are carrying very scanty stocks, and will be unable to remain out of the market much longer.

Prices have been :—

*Soft Foreign Prompt.*—Thursday, £24 10s.; Friday, £24 10s.; Monday, £24 10s.; Tuesday, £24 10s.; Wednesday, £24 6s. 3d.

## German Foundrymen's Technical Association.

The German Foundrymen's Association will hold their 19th ordinary general meeting on May 25 and 26 in Berlin and at the same time will celebrate their 20th anniversary. As a prelude to the general meeting there will be a meeting of the Electric Furnace Committee in the hall of the Geological Institution on Friday, May 24. The agenda of this meeting will include the following lectures: (1) Quality Considerations in Electric Steel Works, by Dipl. Ing. K. v. Kerpely, Campia Turzu (Rumania); (2) Coreless Induction Furnaces, by Dipl. Ing. M. H. Kraemer, Berlin; (3) American Electric Furnace Practice, by Dr. Ing. K. F. Krau, Magdeburg; and (4) Production of Synthetic Grey Iron in the Electric Furnace, by Ing. Nathusius, Mannheim.

On Saturday, May 25, the day before the general meeting itself, there will be held a preliminary meeting in the large Engineering Hall at which the following Papers will be submitted: (1) The Development of a New De-oxidation and Melting Process for Metals, with Special Reference to Copper Alloys, by Dipl. Ing. W. Reitmeister, Kirchmoser; (2) The Employment of Men in the Different Processes of Foundrywork, by Chief Ing. W. Stern, Frankfurt/M.; and (3) The Development of the Metal-Melting Industry and the Cupola-Mixtures during the Last 50 Years. [Older methods of melting, casting, and cupola mixing. Duerre's, Ledebur's and Wust's Books. Newer methods and processes. Low carbon content castings. Alloy metals. Observations regarding patent rights.] By Chief Ing. Chr. Gilles, Berlin.

The agenda of the general meeting, which will take place on Sunday, May 26, at 10 o'clock, announces the following Papers:—

What is the Metallurgical Superiority of the Basic Steel Melting Furnace over the Acid Steel Furnace? by Dr. Ing. E. Piwowarsky, Aachen.

The Education of Foundrymen: (a) at High Schools and Technical Colleges, by Prof. Dr. Ing. M. Paschke, Clausthal; (b) at Technical Secondary Schools, by Prof. Dr. Ing. Geigor, Oberesslingen.

Technique and Economy, by Prof. Dr. phil. nat. Friedrich Dessauer M.a.R., Frankfurt/M.

Further, the programme includes the following visits: (1) Visit to the Eisen & Metal.-Giessereien of Julius Pintsch A.G. Fuerstenwalde; (2) Visit to the Eisengiesserei of Carl Schoening, G.m.b.H. Berlin-Reinickendorf-Ost; (3) Visit to the largest technical trade exhibition in the world, embracing "Gas and Water."

In conjunction with the general meeting, lectures on Foundry Technical Subjects will be given at the High School from May 28 to 30, which are being arranged by the Technical High School of Berlin in conjunction with the Association of German Technical Foundrymen, the German Metallurgical Society and the Federation of German Non-Ferrous Foundry Owners.

Information with regard to these arrangements and the general meeting of the Associations can be had from Vereins deutscher Giessereifachleute, Berlin, NW. 7, Friedrich-str. 100.

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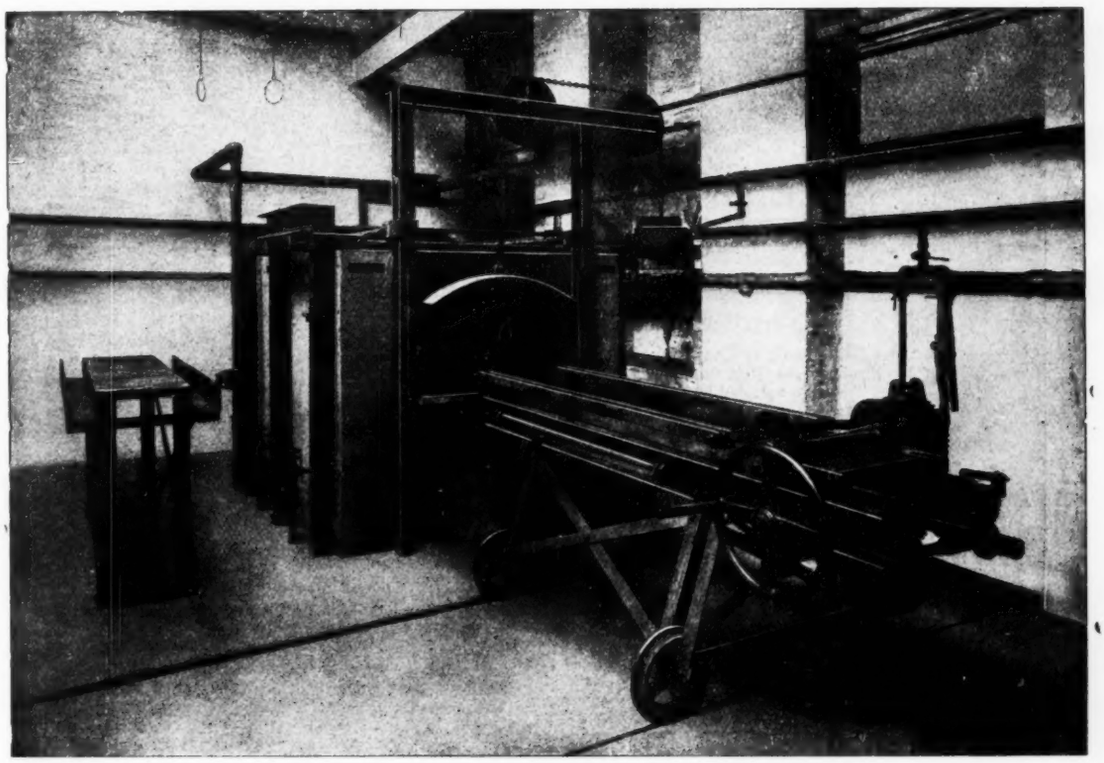
# HEAT TREATMENT UNDER IDEAL CONDITIONS



## GIBBONS'S NEW PATENT REGENERATIVE GAS FURNACE AND PATENT FURNACE CHARGING MACHINE

## REDUCE ANNEALING & CARBURIZING COSTS

*Illustrated Lists and Full Particulars from :*

**GIBBONS BROS. Ltd., Dibdale Works, DUDLEY, WORCS.**

# WEEKLY PRICE CURRENT.

## COPPER.

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 78 | 0 | 0 |
| Three months | 75 | 7 | 6 |
| Electrolytic | 84 | 0 | 0 |
| Tough | 79 | 5 | 0 |
| Best selected | 79 | 15 | 0 |
| Sheets | 112 | 0 | 0 |
| India | 98 | 0 | 0 |
| Wire bars | 84 | 12 | 6 |
| Do. May | 84 | 12 | 6 |
| Do. June | 84 | 12 | 6 |
| Ingot bars | 84 | 12 | 6 |
| H.C. wire rods | 86 | 15 | 0 |
| Off. av. cash, April | 81 | 2 | 7½ |
| Do. 3 mths., April | 78 | 19 | 8½ |
| Do., Sttlmnt., April | 81 | 2 | 8½ |
| Do., Electro, April | 90 | 17 | 11½ |
| Do., B.S., April | 85 | 16 | 11½ |
| Aver. spot price, copper, Apl. | 81 | 2 | 7½ |
| Do. wire bars, April | 92 | 7 | 10½ |

Solid drawn tubes 15½d.
Brazed tubes 15½d.
Wire 12½d.

## BRASS.

Solid drawn tubes 13d.
Brazed tubes 15d.
Rods, drawn 12½d.
Rods, extd. or rlld. 8½d.
Sheets to 10 w.g. 11½d.
Wire 11½d.
Rolled metal 10½d.
Yellow metal rods 8½d.
Do. 4 × 4 Squares 9d.
Do. 4 × 3 Sheets 9½d.

## TIN.

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 200 | 17 | 6 |
| Three months | 202 | 5 | 0 |
| English | 201 | 10 | 0 |
| Bars | 201 | 0 | 0 |
| Straits | 199 | 5 | 0 |
| Australian | 198 | 15 | 0 |
| Eastern | 202 | 5 | 0 |
| Banca | 202 | 15 | 0 |
| Off. av. cash, April | 206 | 19 | 7½ |
| Do., 3 mths., April | 208 | 1 | 5½ |
| Do., Sttlmt., April | 207 | 0 | 0 |
| Aver. spot, April | 206 | 19 | 7½ |

## SPELTER.

| | £ | s. | d. |
|---|---|---|---|
| Ordinary | 26 | 12 | 6 |
| Remelted | 25 | 5 | 0 |
| Hard | 21 | 10 | 0 |
| Electro 99.9 | 29 | 5 | 0 |
| English | 26 | 15 | 0 |
| India | 23 | 10 | 0 |
| Zinc dust (Nom.) | 36 | 10 | 0 |
| Zinc ashes | 9 | 0 | 0 |
| Off. aver., April | 26 | 13 | 8 9/16 |
| Aver., spot, April | 26 | 15 | 2½ |

## LEAD.

| | £ | s. | d. |
|---|---|---|---|
| Soft foreign ppt. | 24 | 6 | 3 |
| English | 25 | 15 | 0 |
| Off. average, April | 24 | 11 | 10½ |
| Average spot, April | 24 | 15 | 7½ |

## ZINC SHEETS, &c.

| | £ | s. | d. |
|---|---|---|---|
| Zinc sheets, English | 34 | 10 | 0 |
| Do. V.M. ex whf. | 33 | 2 | 6 |
| Rods | 42 | 0 | 0 |
| Boiler plates | 31 | 0 | 0 |
| Battery plates | 32 | 0 | 0 |

## ANTIMONY.

| | £ | s. | d. |
|---|---|---|---|
| Special brands, Eng. | 54 | 10 | 0 |
| Chinese | 36 | 10 | 0 |
| Crude | 33 | 0 | 0 |

## QUICKSILVER.

Quicksilver £22 3 9

## FERRO-ALLOYS AND STEEL-MAKING METALS.

| | £ | s. | d. |
|---|---|---|---|
| Ferro-silicon— | | | |
| 25% | 7 | 17 | 6 |
| 45/50% | 12 | 0 | 0 |
| 75% | 19 | 10 | 0 |

Ferro-vanadium—
35/50% ..13/4 lb. Va.
Ferro-molybdenum—
70/75% c. free ..3/10 lb. Mo.
Ferro-titanium—
23/25% carbonless 11d. lb.
Ferro-phosphorus, 20/25% £16 10 0
Ferro-tungsten—
80/85%, c. fr. 2/10¼ lb.
Tungsten metal powder—
98/99% 3/0¼ lb.
Ferro-chrome—
2/4% car. £33 0 0
4/6% car. £25 0 0
6/8% car. £23 0 0
8/10% car. £22 17 6
Ferro-chrome—
Max. 2% car. £34 5 0
Max. 1% car. £37 17 6
Max. 0·70% car. £41 15 0
70%, carbonless 1/2 lb.
Nickel—99% cubes, or pellets £175 0 0
Ferro-cobalt 9/4 lb.
Aluminium 98/99% £95 0 0
Metallic chromium—
96/98% 2/6 lb.
Ferro-manganese (net)—
76/80% loose £13 15 0
76/80% packed £14 15 0
76/80%, export £14 10 0
Metallic manganese—
94/96%, carbonless 1/6 lb.
Per ton unless otherwise stated.

## HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten £0 2 0
Finished bars, 18% tungsten £0 2 9
Per lb. net, d/d buyers' works.
Extras—
Rounds and squares, 3 in. and over 4d. lb.
Rounds and squares, under ½ in. to ¼ in. 3d. lb.
Do., under ¼ in. to 7/16 in. 1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ¼ in. 3d. lb.
Do., under ½ in. × ¼ in. 1/- lb.
Bevels of approved sizes and sections 6d. lb.
Bars cut to length, 10% extra

## SCRAP.

| South Wales— | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Heavy steel | | | | | 4 | 0 | 0 |
| Bundled steel and shrngs. | 3 | 15 | 0 | to 3 | 19 | 0 | |
| Mixed iron and steel | 3 | 12 | 6 | to 3 | 15 | 0 | |
| Heavy cast iron | | | | | 3 | 7 | 6 |
| Good machinery for foundries | | | | | 3 | 10 | 0 |
| Cleveland— | | | | | | | |
| Heavy steel | | | | | 3 | 3 | 6 |
| Steel turnings | | | | | 2 | 18 | 6 |
| Cast iron borings | | | | | 2 | 15 | 0 |
| Heavy forge | | | | | 3 | 15 | 0 |
| W.I. piling scrap | | | | | 3 | 10 | 0 |
| Cast-iron scrap | 3 | 2 | 6 | to 3 | 6 | 0 | |
| Lancashire— | | | | | | | |
| Cast-iron scrap | 3 | 0 | 0 | to 3 | 12 | 6 | |
| Hvy. wrought | | | | | 3 | 15 | 0 |
| Steel turnings | 2 | 17 | 6 | to 3 | 0 | 0 | |
| Scotland— | | | | | | | |
| Heavy steel | | | | | 3 | 15 | 0 |
| Cast-iron borings | | | | | 2 | 15 | 0 |
| Wrought-iron piling | | | | | 3 | 12 | 6 |
| Heavy machinery | | | | | 3 | 13 | 6 |

London—Merchants' buying prices delivered yard.

| | £ | s. | d. |
|---|---|---|---|
| Copper (clean) | 64 | 0 | 0 |
| Brass | 41 | 0 | 0 |
| Lead (less usual draft) | 20 | 10 | 0 |
| Tea lead | 16 | 10 | 0 |
| Zinc | 17 | 0 | 0 |
| New aluminium cuttings | 67 | 0 | 0 |
| Braziery copper | 55 | 0 | 0 |
| Gunmetal | 52 | 0 | 0 |
| Hollow pewter | 160 | 0 | 0 |
| Shaped black pewter | 105 | 0 | 0 |

## PIG-IRON.

*(f.o.t. unless otherwise stated.)*

N.E. Coast—
Foundry No. 1 71/-
Foundry No. 3 68/6
Foundry No. 4 67/6
Forge No. 4 67/-
Hematite No. 1 74/6
Hematite M/Nos. 74/-

N.W. Coast—
Hem. M/Nos. d/d Glas. 83/6
„ d/d Birm. 91/-

Midlands—
Staffs. common* —
„ No. 4 forge* 69/6
„ No. 3 fdry* 73/6
Shrops. basic —
„ Cold blast, ord. —
„ „ roll iron —
Northants forge* 65/-
„ fdry. No. 3* 69/-
Derbyshire forge* 68/6
„ fdry. No. 3* 72/6
„ basic* —
* d/d Black Country dist.

Scotland—
Foundry No. 1 75/-
„ No. 3 72/6
Hem. M/Nos. 78/-

Sheffield (d/d district)—
Derby forge 63/6
„ fdry. No. 3 67/6
Lincs. forge 68/6
„ fdry. No. 3 72/6
E.C. hematite 85/-
W.C. hematite 87/-

Lincs. (at furnaces)—
Forge No. 4 —
Foundry No. 3 —
Basic —

Lancashire (d/d eq. Man.)—
Derby forge —
„ fdry. No. 3 71/-
Northants foundry No. 3 —
Dalzell, No 3 (special) 102/6 to 105/-
Summerlee, No. 3 90/-
Glengarnock, No. 3 —
Gartsherrie, No. 3 90/-
Monkland, No. 3 90/-
Shotts, No. 3 90/-

## FINISHED IRON AND STEEL.

*Usual District deliveries for iron; delivered consumers' station for steel.*

| Iron— | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Bars (cr.) nom. | | | | | 10 | 15 | 0 |
| Nut and bolt iron | 9 | 0 | 0 | to 9 | 5 | 0 | |
| Hoops | | | | | 11 | 10 | 0 |
| Marked bars (Staffs.) f.o.t. | | | | | 12 | 0 | 0 |
| Gas strip | | | | | 11 | 10 | 0 |
| Bolts and nuts, ¾ in. × 4 in. | | | | | 15 | 5 | 0 |
| Steel— | | | | | | | |
| Ship plates | 8 | 7 | 6 | to 8 | 12 | 6 | |
| Boiler plts. | | | | | 10 | 10 | 0 |
| Chequer plts. | | | | | 10 | 12 | 6 |
| Angles | | | | | 7 | 17 | 6 |
| Tees | | | | | 8 | 17 | 6 |
| Joists | | | | | 7 | 17 | 6 |
| Rounds and squares, 3 in. to 5½ in. | | | | | 8 | 17 | 6 |
| Rounds under 3 in. to ¾ in. (Untested) | | | | | 8 | 0 | 0 |
| | | | | and | upwards | | |
| Flats, over 5 in. wide and up | | | | | 8 | 7 | 6 |
| Flats, 5 in. to 1¼ in. | | | | | 7 | 17 | 6 |
| Rails, heavy | | | | | 8 | 10 | 0 |
| Fishplates | | | | | 12 | 10 | 0 |
| Hoops (Staffs.) | | | | | 11 | 0 | 0 |
| Black sheets, 24g. | 10 | 0 | 0 | to 10 | 10 | 0 | |
| Galv.cor.shts., 24g. | 13 | 7 | 6 | to 13 | 12 | 6 | |
| Galv. fencing wire 8g. plain | | | | | 12 | 0 | 0 |
| Billets, soft | 6 | 7 | 6 | to 7 | 0 | 0 | |
| Billets hard | 7 | 10 | 0 | to 8 | 2 | 6 | |
| Sheet bars | 6 | 5 | 0 | to 6 | 10 | 0 | |
| Tin bars | 6 | 5 | 0 | to 6 | 10 | 0 | |

## PHOSPHOR BRONZE.

| | Per lb. basis. |
|---|---|
| Strip | 1/4 |
| Sheet to 10 w.g. | 1/5 |
| Wire | 1/6½ |
| Rods | 1/5 |
| Tubes | 1/9 |
| Castings | 1/4 |

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

## NICKEL SILVER, &c.

| | per lb. |
|---|---|
| Ingots for raising | 10d. to 1/4 |
| Rolled— | |
| To 9 in. wide | 1/4 to 1/10 |
| To 12 in. wide | 1/4½ to 1/10½ |
| To 15 in. wide | 1/4½ to 1/10½ |
| To 18 in. wide | 1/5 to 1/11 |
| To 21 in. wide | 1/5½ to 1/11½ |
| To 25 in. wide | 1/6 to 2/- |
| Ingots for spoons and forks | 10d. to 1/6½ |
| Ingots rolled to spoon size | 1/1 to 1/9½ |
| Wire round— | |
| 3/0 to 10 G. | 1/7½ to 2/2½ |

with extras according to gauge.

## AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

| | Dols. |
|---|---|
| No. 2X foundry, Phila. | 21.76 |
| No. 2 foundry, Valley | 18.00 |
| No. 2 foundry, Birm. | 15.50 |
| Basic | 19.76 |
| Bessemer | 20.79 |
| Malleable | 20.01 |
| Grey forge | 19.26 |
| Ferro-mang. 80% d/d | 105.00 |
| O.-h. rails, h'y at mill | 43.00 |
| Bess billets | 34.00 |
| O.-h. billets | 34.00 |
| O.-h. sheet bars | 36.00 |
| Wire rods | 42.00 |
| | Cents. |
| Iron bars, Phila. | 2.12 |
| Steel bars | 1.95 |
| Tank plates | 1.95 |
| Beams, etc. | 1.90 |
| Skelp, grooved steel | 1.90 |
| Skelp, sheared steel | 1.90 |
| Steel hoops | 2.20 |
| Sheets, black, No. 24 | 2.85 |
| Sheets, galv., No. 24 | 3.60 |
| Sheets, blue an'l'd, 9 and 10 | 2.10 |
| Wire nails | 2.65 |
| Plain wire | 2.50 |
| Barbed wire, galv. | 3.30 |
| Tinplates, 100 lb. box | $5.35 |

## COKE (at ovens).

Welsh foundry 25/- to 30/-
„ furnace 21/- to 25/-
Durham and North.
„ foundry 16/- to 18/-
„ furnace 16/6
Midlands, foundry —
„ furnace 19/- and up

## TINPLATES.

f.o.b. Bristol Channel ports.

| | | | |
|---|---|---|---|
| I.C. Cokes | 20×14 box | | 18/3 |
| „ | 28×20 „ | | 36/6 |
| „ | 20×10 „ | | 26/3 |
| „ | 18¾×14 „ | | 18/9 |
| C.W. | 20×14 „ | | 15/- |
| „ | 28×20 „ | | 33/6 |
| „ | 20×10 „ | | 21/3 |
| „ | 18¾×14 „ | | 15/- |
| Terneplates | 28×20 | | 33/6 per box basis f.o.b. |

## SWEDISH CHARCOAL IRON & STEEL.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Pig-iron | £6 | 0 | 0 | to | £7 | 10 | 0 |
| Bars, hammered, basis | £17 | 10 | 0 | to | £18 | 10 | 0 |
| Bars and nail-rods, rolled, basis | £15 | 15 | 0 | to | £16 | 15 | 0 |
| Blooms | £10 | 0 | 0 | to | £12 | 0 | 0 |
| Keg steel | £32 | 0 | 0 | to | £33 | 0 | 0 |
| Faggot steel | £20 | 0 | 0 | to | £24 | 0 | 0 |
| Bars and rods, dead soft, steel | £10 | 0 | 0 | to | £14 | 0 | 0 |

All per English ton, f.o.b. Gothenburg.

### TUBES AND FITTINGS.

Up to and incl. 6 in.

| | *Tubes.* | *Fittings.* |
|---|---|---|
| Gas | 67½% | 50% |
| Water | 63¾% | 45% |
| Steam | 60% | 40% |

W.I. 10% extra.

### DAILY FLUCTUATIONS.

**Standard Copper** (cash).

| | | | £ | s. | d. | | |
|---|---|---|---|---|---|---|---|
| May | 2 | .. | 78 | 10 | 0 | inc. | 5/- |
| ,, | 3 | .. | 79 | 0 | 0 | ,, | 10/- |
| ,, | 6 | .. | 79 | 17 | 6 | ,, | 17/6 |
| ,, | 7 | .. | 79 | 2 | 6 | dec. | 15/- |
| ,, | 8 | .. | 78 | 0 | 0 | ,, | 22/6 |

**Electrolytic Copper.**

| | | | £ | s. | d. | | |
|---|---|---|---|---|---|---|---|
| May | 2 | .. | 83 | 0 | 0 | No change | |
| ,, | 3 | .. | 83 | 10 | 0 | inc. | 10/- |
| ,, | 6 | .. | 84 | 5 | 0 | ,, | 15/- |
| ,, | 7 | .. | 84 | 5 | 0 | No change | |
| ,, | 8 | .. | 84 | 0 | 0 | dec. | 5/- |

**Standard Tin** (cash).

| | | | £ | s. | d. | | |
|---|---|---|---|---|---|---|---|
| May | 2 | .. | 196 | 5 | 0 | dec. | 10/- |
| ,, | 3 | .. | 197 | 0 | 0 | inc. | 15/- |
| ,, | 6 | .. | 197 | 10 | 0 | ,, | 10/- |
| ,, | 7 | .. | 197 | 15 | 0 | ,, | 5/- |
| ,, | 8 | .. | 200 | 17 | 6 | ,, | 62/6 |

**Tin** (English ingots).

| | | | £ | s. | d. | | |
|---|---|---|---|---|---|---|---|
| May | 2 | .. | 197 | 10 | 0 | dec. | 30/- |
| ,, | 3 | .. | 198 | 5 | 0 | inc. | 15/- |
| ,, | 6 | .. | 198 | 10 | 0 | ,, | 5/- |
| ,, | 7 | .. | 199 | 0 | 0 | ,, | 10/- |
| ,, | 8 | .. | 201 | 10 | 0 | ,, | 50/- |

**Zinc Sheets** (English).

| | | | £ | s. | d. | | |
|---|---|---|---|---|---|---|---|
| May | 2 | .. | 34 | 10 | 0 | No change | |
| ,, | 3 | .. | 34 | 10 | 0 | ,, | ,, |
| ,, | 6 | .. | 34 | 10 | 0 | ,, | ,, |
| ,, | 7 | .. | 34 | 10 | 0 | ,, | ,, |
| ,, | 8 | .. | 34 | 10 | 0 | ,, | ,, |

**Spelter** (ordinary).

| | | | £ | s. | d. | | |
|---|---|---|---|---|---|---|---|
| May | 2 | .. | 26 | 12 | 6 | No change | |
| ,, | 3 | .. | 26 | 11 | 3 | dec. | 1/3 |
| ,, | 6 | .. | 26 | 8 | 9 | ,, | 2/6 |
| ,, | 7 | .. | 26 | 7 | 6 | ,, | 1/3 |
| ,, | 8 | .. | 26 | 12 | 6 | inc. | 5/- |

**Lead** (English).

| | | | £ | s. | d. | | |
|---|---|---|---|---|---|---|---|
| May | 2 | .. | 26 | 0 | 0 | No change | |
| ,, | 3 | .. | 26 | 0 | 0 | ,, | ,, |
| ,, | 6 | .. | 26 | 0 | 0 | ,, | ,, |
| ,, | 7 | .. | 26 | 0 | 0 | ,, | ,, |
| ,, | 8 | .. | 25 | 15 | 0 | dec. | 5/- |

### AVERAGE MONTHLY PRICES OF FURNACE COKE D/D MIDDLESBROUGH.

| Year | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Yearly average. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. |
| 1895 .. .. | 0 12 3 | 0 12 3 | 0 12 3 | 0 12 3 | 0 12 3 | 0 12 3 | 0 12 3 | 0 12 3 | 0 12 6 | 0 13 3 | 0 13 3 | 0 13 3 | 0 12 5½ |
| 1896 .. .. | 0 13 0 | 0 13 0 | 0 13 6 | 0 13 6 | 0 13 6 | 0 13 9 | 0 13 6 | 0 13 3 | 0 13 3 | 0 13 3 | 0 13 6 | 0 13 6 | 0 13 4½ |
| 1897 .. .. | 0 13 6 | 0 13 6 | 0 13 6 | 0 13 3 | 0 13 3 | 0 13 6 | 0 13 6 | 0 13 6 | 0 13 3 | 0 13 3 | 0 13 0 | 0 13 6 | 0 13 4½ |
| 1898 .. .. | 0 13 6 | 0 13 6 | 0 15 0 | 0 13 6 | 0 13 9 | 0 14 0 | 0 14 3 | 0 14 3 | 0 14 6 | 0 14 9 | 0 15 0 | 0 15 6 | 0 14 3½ |
| 1899 .. .. | 0 15 6 | 0 15 6 | 0 16 0 | 0 16 3 | 1 0 0 | 1 1 0 | 1 1 6 | 1 1 6 | 1 1 6 | 1 1 0 | 1 2 0 | 1 5 0 | 0 19 8½ |
| 1900 .. .. | 1 5 0 | 1 5 6 | 1 6 6 | 1 8 0 | 1 8 6 | 1 9 0 | 1 9 0 | 1 8 0 | 1 8 0 | 1 7 0 | 1 3 0 | 0 19 0 | 1 6 4½ |
| 1901 .. .. | 0 17 6 | 0 14 0 | 0 13 0 | 0 14 0 | 0 14 6 | 0 15 0 | 0 15 3 | 0 15 3 | 0 15 9 | 0 16 6 | 0 16 9 | 0 16 9 | 0 16 4½ |
| 1902 .. .. | 0 16 9 | 0 15 0 | 0 15 0 | 0 15 0 | 0 15 0 | 0 15 3 | 0 15 3 | 0 15 3 | 0 15 6 | 0 16 0 | 0 16 6 | 0 16 0 | 0 15 5 |
| 1903 .. .. | 0 15 9 | 0 16 0 | 0 16 3 | 0 16 9 | 0 16 6 | 0 16 3 | 0 16 0 | 0 15 9 | 0 15 6 | 0 15 0 | 0 14 6 | 0 14 0 | 0 15 8½ |
| 1904 .. .. | 0 13 9 | 0 13 9 | 0 13 3 | 0 14 3 | 0 14 6 | 0 14 3 | 0 14 3 | 0 14 3 | 0 14 3 | 0 14 0 | 0 14 0 | 0 14 6 | 0 14 1½ |
| 1905 .. .. | 0 14 9 | 0 15 3 | 0 15 3 | 0 15 3 | 0 15 6 | 0 15 6 | 0 15 6 | 0 15 6 | 0 15 6 | 0 15 6 | 0 15 9 | 0 17 0 | 0 15 5½ |
| 1906 .. .. | 0 17 6 | 0 17 6 | 0 17 0 | 0 17 0 | 0 16 6 | 0 16 6 | 0 17 0 | 0 17 0 | 0 18 3 | 0 18 6 | 0 19 0 | 1 0 0 | 0 17 8½ |
| 1907 .. .. | 1 4 6 | 1 5 0 | 1 5 0 | 1 0 6 | 1 2 0 | 1 1 0 | 1 1 0 | 1 1 0 | 1 2 0 | 1 1 6 | 1 0 0 | 0 17 0 | 1 1 8½ |
| 1908 .. .. | 0 16 0 | 0 16 0 | 0 15 6 | 0 16 0 | 0 16 3 | 0 16 0 | 0 15 6 | 0 15 6 | 0 15 6 | 0 15 3 | 0 16 0 | 0 16 0 | 0 15 9½ |
| 1909 .. .. | 0 16 0 | 0 15 3 | 0 15 0 | 0 14 9 | 0 15 6 | 0 15 9 | 0 15 6 | 0 15 6 | 0 16 6 | 0 17 0 | 0 17 6 | 0 17 0 | 0 15 1½ |
| 1910 .. .. | 0 18 4½ | 0 18 6½ | 0 18 0 | 0 18 0 | 0 17 10½ | 0 17 0 | 0 16 1½ | 0 15 9½ | 0 15 11 | 0 16 0 | 0 15 9½ | 0 15 8 | 0 16 1 |
| 1911 .. .. | 0 16 0 | 0 15 10½ | 0 15 6 | 0 15 3 | 0 14 9 | 0 14 6 | 0 14 6 | 0 14 6 | 0 14 6 | 0 14 11½ | 0 15 0½ | 0 16 3½ | 0 15 1½ |
| 1912 .. .. | 0 17 3 | 0 17 3 | 0 18 6 | 0 18 10 | 0 19 0 | 0 19 4½ | 0 19 10½ | 1 0 9½ | 1 2 9 | 1 4 1½ | 1 5 8½ | 1 8 6 | 1 1 0 |
| 1913 .. .. | 1 5 9 | 1 4 11 | 1 5 0 | 1 5 0 | 1 4 9½ | 1 0 4½ | 0 19 5½ | 0 18 3 | 0 18 0 | 0 18 2½ | 0 18 6 | 0 18 6 | 1 1 4½ |
| 1914 .. .. | 0 18 2 | 0 17 1 | 0 17 0 | 0 17 0 | 0 17 4 | 0 17 6 | 0 17 6 | 0 18 5 | 0 18 4 | 0 17 9 | 0 17 6 | 0 18 5 | 0 17 8 |
| 1915 .. .. | 0 17 10½ | 0 17 9 | 1 0 4½ | 1 7 7½ | 1 9 4½ | 1 10 7½ | 1 9 7 | 1 7 3 | 1 5 4 | 1 4 9 | 1 9 6 | 1 13 0 | 1 6 1 |
| 1916 .. .. | 1 10 9 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6½ |
| 1917 .. .. | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 14 3 | 1 15 6 | 1 11 2½ |
| 1918 .. .. | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 |
| 1919 .. .. | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 2 1 6 | 2 1 6 | 2 3 9 | 2 10 6 | 2 10 6 | 2 10 6 | 2 10 6 | 2 10 6 | 2 3 5 |
| 1920 .. .. | 2 12 3 | 2 14 0 | 2 19 0 | 2 19 0 | 3 3 8 | 3 6 0 | 3 6 0 | 3 6 0 | 3 6 0 | 3 6 0 | 3 6 0 | 3 6 0 | 3 2 6 |
| 1921 .. .. | 3 1 0½ | 2 19 0 | 2 16 0 | 2 7 0 | 2 6 6 | 2 6 6 | 2 0 6 | 2 0 0 | 1 13 11 | 1 12 9 | 1 10 4½ | 1 8 3 | 2 3 6½ |
| 1922 .. .. | 1 7 0½ | 1 8 1½ | 1 9 7½ | 1 8 4½ | 1 7 11½ | 1 7 3 | 1 6 9½ | 1 6 10½ | 1 7 0½ | 1 10 2½ | 1 10 0 | 1 9 11½ | 1 8 3½ |
| 1923 .. .. | 1 11 3 | 1 14 6 | 2 0 1½ | 2 2 8½ | 2 4 4½ | 2 2 10½ | 2 1 0½ | 2 1 6 | 2 0 9½ | 1 18 9 | 1 18 8½ | 1 18 3 | £1 19 7½ |
| 1924 .. .. | 1 16 6½ | 1 14 9 | 1 11 11½ | 1 10 0½ | 1 8 1½ | 1 7 8½ | 1 7 3 | 1 6 3 | 1 6 0 | 1 5 0 | 1 5 0 | 1 5 0 | 1 9 5½ |
| 1925 .. .. | 1 4 10½ | 1 4 1½ | 1 13 3 | 1 2 4½ | 1 2 2½ | 1 1 5½ | 1 1 3½ | 1 4 9 | 0 18 10½ | 0 18 4½ | 0 19 6½ | 1 1 4½ | 1 2 8½ |
| edi | | | | | | | | | | | | | (5 months) |
| 1926 .. .. | 1 2 1½ | 1 0 9 | 0 19 2½ | 0 18 6½ | Strike | Strike | Strike | Strike | Strike | Strike | Strike | 1 5 0 | 1 1 4 |
| 1927 .. .. | 1 5 6 | 1 4 9½ | 1 6 1½ | 1 3 9 | 1 2 6 | 1 0 8½ | 0 19 4½ | 0 19 0 | 0 18 7½ | 0 18 0 | 0 17 10½ | 0 17 6 | 1 1 1½ |
| 1928 .. .. | 0 17 6 | 0 17 10½ | 0 18 0½ | 0 17 11½ | 0 17 8½ | 0 17 6½ | 0 17 7½ | 0 17 6½ | 0 17 6 | 0 17 7½ | 0 17 7½ | 0 17 6 | 0 17 8 |
| 1929 .. .. | 0 17 7½ | 0 18 0 | 0 19 0 | 0 19 6½ | — | — | — | — | — | — | — | — | — |


WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARK

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

## SMALL ADVERTISEMENTS.

### *Notice.*

**Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-.**

***(A remittance should accompany instructions.)***

### SITUATIONS VACANT AND WANTED.

FOUNDRY CHEMIST and METALLURGIST desires change; 14 years' experience of ferrous and non-ferrous analysis; past 9 years with firm engaged in mass production of grey-iron motor cylinder castings, in charge of cupola and melting.—Box 214, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY FOREMAN desires position; experienced all branches engineering and jobbing work, iron and non-ferrous; knowledge of metallurgy and mixing of metals by analysis; good organiser; can get maximum production and consistent results.—Box 216, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

A SALARIED REPRESENTATIVE is required for leading firm of foundry supplies manufacturers. Applicant must have held leading position in large foundry, and possess the necessary qualifications of a good salesman.—Apply, Box 212, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

ROLLCASTER Wanted; must be able show success in all classes of Cast-Iron Rolls, Chilled and Grain.—Applications, stating salary required, to Box 218, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

WORKING CHARGE-HAND Wanted for small foundry in modern works manufacturing ferro-silicon welding rods; must have cupola and crucible experience.—Alloy Welding Processes, Limited, Ferry Lane Works, Forest Road, Walthamstow, E.17.

FOREMAN PATTERN-MAKER WANTED; wood, lead and plaster; experience in gas-stove trade essential.—Write fully, stating experience, age, and salary required, also whether in employment, Sidney Flavel & Company, Limited, Leamington.

### PROPERTY.

**11 ACRES WORKS SITE.**
**SHEFFIELD.**
**145,000 Sq. Ft. of SHOPPING,**
Compact and Convenient.
**SIDING CONNECTIONS**
with L.M. & S. and L. & N.E. Rlys.
**WELL-BUILT & COMMODIOUS OFFICES**
Will Sell whole or in lots to suit customers or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—
**THOS. W. WARD, LTD.,**
ALBION WORKS, SHEFFIELD.

A TRAFFORD PARK BARGAIN.—Modern Foundry with own railway sidings, excellent warehouse, packing room and fine offices, centrally heated, for SALE. Premises are all one storey and easily adaptable for other trades. Cost £20,000 in 1921. For a quick sale, owners will take £2,000, including two 4-ft. modern cupolas and Keith-Blackman motor and fan.—F. S. Airey, Entwistle & Company, 10, Norfolk Street, Manchester.

### PATENTS AND TRADE MARKS.

PROTECT YOUR IDEAS.—Free, Advice and Handbook on patenting inventions and registering trade marks by Registered Agent with 43 years' experience.—King's Patent Agency, Limited, 146A, Queen Victoria Street, E.C.4.

### PATENTS AND TRADE MARKS—*Continued.*

THE Proprietor of British Patents Nos. 163232 and 167386, both dated July 30, 1920, and British Patents Nos. 229184 and 232821, both dated July 14, 1924, relating to "Improvements in Chain Grates," "Improvements in Furnaces," "Improvements in Mechanical Stokers," and "Improvements in Furnaces" respectively, is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above Patents and ensuring their practical working in Great Britain.—All inquiries to be addressed to B. Singer, Steger Building, Chicago, Illinois.

### MACHINERY.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. Brealey & Company, Limited, Prospect Works, Hawksley Avenue, Sheffield.

RUBBLE OR SAND TIPPING CRANE SKIPS.
Four 3 ft. 6 in. dia., 3 ft. deep.
One 2 ft. 6 in. dia., 2 ft. 7 in. deep.
One 2 ft. 4 in. dia., 3 ft. 6 in. deep.
Price £4 10s. each, free on rail.
For further particulars write Box 222, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

MORTAR OR LOAM GRINDING MILL.
One Grinding Mill, under-driven by belt; pan 6 ft. 6 in. dia., 20 in. deep; two cast-iron rolls 3 in. dia.; 12-in. face; self contained. Price £30, free on rail in Co. Durham.
For further particulars write Box 220, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

7-in. swing CHURCHILL Internal Grinding Machine.
10-in. x 20-in. LANDIS Plain Centre Grinding Machine, with travelling head.
No. 7A "SUNDERLAND" Gear Generating Machine, capacity 18 in. dia. x 9 in. wide.
No. 60 "HEALD" Internal Grinding Head, with planetary head.
Two 5-ton "Ransome & Rapier" LOCO. STEAM CRANES, 35-ft. jib, all motions, 100 lbs. w.p.
Six 2-ft. gauge 4-wheel LOCOMOTIVES, Kerr Stuart, cylinders 6 in. x 9 in.; two 1922 make, one 1918 make, and three 1915 make; 140 lbs. w.p.
One good secondhand WATER-TUBE BOILER, by Babcock & Wilcox, Limited; steam drum 22 ft. long overall x 3 ft. 6 in. dia.; re-insurable at a working steam pressure of 180 lbs. per sq. in.
Large stock of very good secondhand FLAT-ENDED CIRCULAR BOILER STORAGE TANKS.
(ASK FOR "ALBION" MACHINERY CATALOGUE.)
**THOS. W. WARD, LTD.,**
ALBION WORKS, SHEFFIELD.

OVERHEAD AND RADIAL CRANES.
One 3-ton "Morris" Hand-operated Overhead Travelling Crane, Single-joist Type, Span 20 ft.
One 5-ton "Morris" Hand-operated Overhead Travelling Crane, Double-joist Type, Two Lifting Speeds, Gravity Lowering, Span 40 ft.
One 2-ton "Morris" Self-contained Radial Jib Crane with Barrel Standard; height Crane-hook to Floor, 11 ft. 6 in.; Radius about 14 ft. 6 in.
All for sale cheap. For further particulars and price write, Box 210, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

### MISCELLANEOUS.

BRITISH-MADE STRAW ROPE; Samples and Prices.—Apply, Slough Straw Rope Works, Estate Office, Long Melford, Suffolk.

GANISTER, best quality, for cupolas, also for Steel Works.—Astbury Silica Company, "The Brooms," Park Lane, Congleton.

### MISCELLANEOUS—*Continued.*

BRASSFOUNDRY RESIDUES. — Ashes, Skimmings, Grindings, Dust, bought for best prices; collected by lorry radius 30 miles London, or ex rail beyond.—Communications, Kinrix, 199-201, Warwick Road, London, W.14. 'Phone: Western 0273.

FOR SALE.—Du-Ram Patent Steel Moulding Boxes, as used by all the leading foundries. Perfect interchangeability and accuracy together with long life. Inquiries solicited. Quick deliveries.—J. W. Sadler & Company, Limited, Bartle Lane, Great Horton, Bradford.

CHARCOAL.—Powdered, granulated, lump, blacking; inquiries invited.—J. Buchanan & Company, Ashfield Road, Altrincham, Cheshire.

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